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Level 1 Assessment of Uncontrolled Sinter Plant Emissions

Research Triangle Inst, Research Triangle Park, NC

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Industrial Environmental Research Lab, Research Triangle Park, NC

May 79

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16. ABSTRACT The report gives results of sampling and analysis of uncontrolled emissions from two sinter plants, to characterize and quantify the particulate, organic, and inorganic species present. One plant used revert (waste products of other steelmaking operations) material (series 1); the other did not (series 2). In both plants, sampling took place in the windbox gas main before the emission control equipment, using EPA Level 1 environmental assessment methodology. Samples from the sinter plant not using revert material were delayed in shipment for 2 months and, therefore, received a reduced analytical effort. Particulate concentrations of 1405 and 804 mg/cu m and total organic emissions of 25.66 and 4/84 mg/cu m were found for series 1 and 2, respectively. No known carcinogenic organic compounds were identified. Organics in both cases were largely high molecular weight materials. For series 1, concentrations of the different organic categories were in the same relative proportion as in the process feed sample, despite the fact that about 85% of the feed organic was destroyed. Analyses indicate that 12 inorganic components and 5 organic categories might exceed Air-Health MATE values if emitted uncontrolled.

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May 1979

Level 1 Assessment of Uncontrolled Sinter Plant Emissions

by

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Contract No. 68-02-2630
Task No. 3
Program Elements No. 1AB604C and 1BB610C

EPA Project Officer: Robert V. Hendriks

Industrial Environmental Research Laboratory
Office of Energy, Minerals, and Industry
Research Triangle Park, NC 27711

Prepared for

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ABSTRACT

Sampling and analysis of the uncontrolled emissions from two sinter plants, one using revert (waste products of other steelmaking operations) material (Series 1) and one not (Series 2), were undertaken to characterize and quantify the particulate, organic, and inorganic species present. In both cases, sampling took place in the windbox gas main before the emission control equipment using EPA Level 1 Environmental Assessment Methodology. Samples from the sinter plant not using revert material were delayed in shipment for two months and, therefore, received a reduced analytical effort.

Particulate concentrations of 1405 and 804 mg/m^3 and total organic emissions of 25.66 and 4.84 mg/m^3 were found for Series 1 and 2, respectively. No known carcinogenic organic compounds were identified. Organics in both cases were largely high molecular weight materials. For Series 1, concentrations of the different organic categories were in the same relative proportion as found in the process feed sample despite the fact that about 85 percent of the feed organic was destroyed. Also, analyses indicate that 12 inorganic components and five organic categories might exceed AIR-Health MATE values if emitted uncontrolled. Calculated control levels needed ranged from 0 to 99.99 percent.

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The efforts of Dr. Robert Handy of RTI, who directed the organic work and interpreted the IR and LRMS spectra are also appreciated. Appreciation is also expressed to U.S. Steel Corporation and Mr. George Kzapko of Gary Works for their cooperation and assistance with this project.

1.0 INTRODUCTION

Sinter or reclamation plants are used to recover iron ore fines for use in the blast furnace. This is accomplished by blending the ores with coke breeze, limestone, and dolomitic lime and igniting the mixture. During the burning process, the mix fuses into a solid mass which can then be broken and crushed to the appropriate size. At some plants, revert materials (waste products from other steelmaking processes) such as blast furnace flue dust, sludge, borings, turnings, and mill scale are also added to the raw mix.

Sinter plants are of interest to EPA because of their potential for high particulate and organic compound emissions. To collect the required data regarding this potential, EPA contracted with Acurex Corporation for sampling of uncontrolled emissions from two sinter plants at U.S. Steel's Gary, Indiana facility and with Research Triangle Institute (RTI) for sample analysis and data evaluation. These tests were conducted at one plant using revert material (Series 1, Sinter Plant No. 3) and one not using these materials (Series 2, Sinter Plant No. 2).

This report, prepared by RTI, integrates the following information:

1. site description, sampling data, and process operation data supplied by Acurex,
2. process observations and operating data obtained by RTI personnel present during the tests, and
3. results of the chemical analyses.

Section 2.0 is a summary of the data obtained. Section 3.0 presents conclusions based on the data presented herein. A description of the test, including the facilities, process, and the sampling and analysis plan is contained in Section 4.0. The test results are presented in Section 5.0. Details of the analytical results are presented in the Appendices.

Unfortunately, the samples taken by Acurex at the No. 2 Sinter Plant did not arrive at RTI until two months after sampling occurred (delivered to wrong address by UPS). These samples were, therefore, subjected to an unknown storage history. RTI and the EPA Project Officer concluded that a complete Level 1 analysis of these samples was not warranted because of possible sample degradation during storage and, therefore, a reduced level of effort analysis was made.

2.0 SUMMARY

This sampling program, conducted at one sinter plant processing revert materials (Series 1, No. 3 plant) and one not (Series 2, No. 2 plant), was directed toward determining if potentially hazardous materials were produced and whether there is a substantial difference in the emissions from the two plants. Although the decision to reduce the analytical effort on the Series 2 samples made a detailed comparison impossible, it does not prevent a general comparison of the two or an evaluation of the No. 3 plant.

Table 1 presents the uncontrolled particulate emissions for both plants. These data show that, although the No. 3 plant had a higher particulate concentration, the total dust generated per hour was about the same for both plants. Since the No. 2 plant was actually processing less sinter, it is obvious that this plant was using a higher air-to-raw feed ratio resulting in a lower particulate concentration. In both cases the uncontrolled particulate emissions are about 450 kg/hr (1000 lbs/hr). Data in Table 5, Section 5.0, also indicate that a larger fraction of the particulate from the No. 3 plant fell into the less than 3 micron size range. Use of a dust control device with 95 percent collection efficiency, which is within the capability of ESP systems, would be adequate to meet most state discharge regulations.

TABLE 1. SUMMARY OF PARTICULATE DATA, UNCONTROLLED EMISSIONS

Sampling Site	No. 2 Plant	No. 3 Plant
Windbox flow rate, m^3/hr	525,030*	320,150
Particulate concentration, mg/m^3	804	1,405
Particulate generated, kg/hr	420	450
kg/ton feed		1.44

*Based on data obtained during SASS test. Acurex measured flow from the exhaust stack (after ESP) the same week as SASS test and found a substantially lower gas rate.

The total organic content of uncontrolled emissions from the two plants is given in Table 2 and shows that the emissions from the No. 3 plant are about five times greater than those from the No. 2 plant. Most of the organics produced by plant No. 3 were captured in the XAD-2 resin rather than being associated with the particulates; and over half of the organics were in the high boiling (GRAV) range. Since the SASS cyclones and oven operated at 204°C (400°F), substantially hotter than the windbox gas temperature, the organic matter could have originally been associated with the dust and distilled onto the XAD-2 resin during sampling. The predominate organic species emitted was simple aliphatic hydrocarbons, although a wide range of other compound categories were also present. Fused aromatics with molecular weights over 216 were less than 1 mg/m^3.

TABLE 2. SUMMARY OF ORGANIC DATA, UNCONTROLLED EMISSIONS

Sampling Site	No. 2 Plant	No. 3 Plant
Windbox flow rate, m^3/hr	525,030	320,150
Total organic concentration, mg/m^3	4.84	25.66
Total organic generated, kg/hr	2.5	8.2
kg/ton feed		0.03

Low Resolution Mass Spectrograph (LRMS) analysis contained several molecular weights that could be associated with carcinogenic material. A GC-MS run on the XAD-2 sample from Sinter Plant No. 3, however, did not confirm this identification.

Particularly interesting is the observation that the various compound categories are in the same relative proportion in both the XAD-2 and process feed samples. Although this could simply be an artifact of the Level 1 data, one could speculate that because of the sinter processing method used (down-draft combustion) the emitted organics are distilled from the lower part of the mix. The data indicate that about 85 percent of the organics in the raw feed are destroyed. Comparison of the organic category concentrations with AIR-Health MATE values indicate that control may be needed for five categories

(halo aliphatics, substituted benzenes, fused aromatics, hetero nitrogen compounds, and amines). Control needed for these categories could range from zero to 99.99 percent.

A summary of inorganic emissions is given in Table 13, Section 5.0. The data presented therein indicate that the emission of uncontrolled windbox gases would exceed AIR-Health MATE values for copper, nickel, iron, manganese, chromium, calcium, potassium, phosphorus, aluminum, arsenic, lead, and possibly sulfur. In order to meet these criteria, a control efficiency of, respectively, 87, 61, 90-98, 37, 99, 50, 65, 68-97, 91 and 0-99 percent might be needed. Since no testing was done on the controlled effluent, no conclusion is possible as to whether this control is actually achieved.

This report does not contain data proving that carcinogenic organic compounds are generated or data relating to compound or element emission levels after the windbox gases have been treated by the cyclones and ESPs.

3.0 CONCLUSIONS

The data obtained from these tests support the conclusions that:

1. More organic matter is generated by sinter plants processing oily revert materials.
2. These organics are generated in approximately the same proportions as in the raw feed material.
3. About 85 percent of the organics in the feed material are destroyed.
4. Substituted benzenes, fused aromatics, halo aliphatics, hetero nitrogen compounds, amines, and 12 inorganic elements are generated at sufficiently high levels that some degree of effluent control may be needed.

4.0 PROCESS DESCRIPTION AND TESTING PROGRAM

4.1 FACILITIES

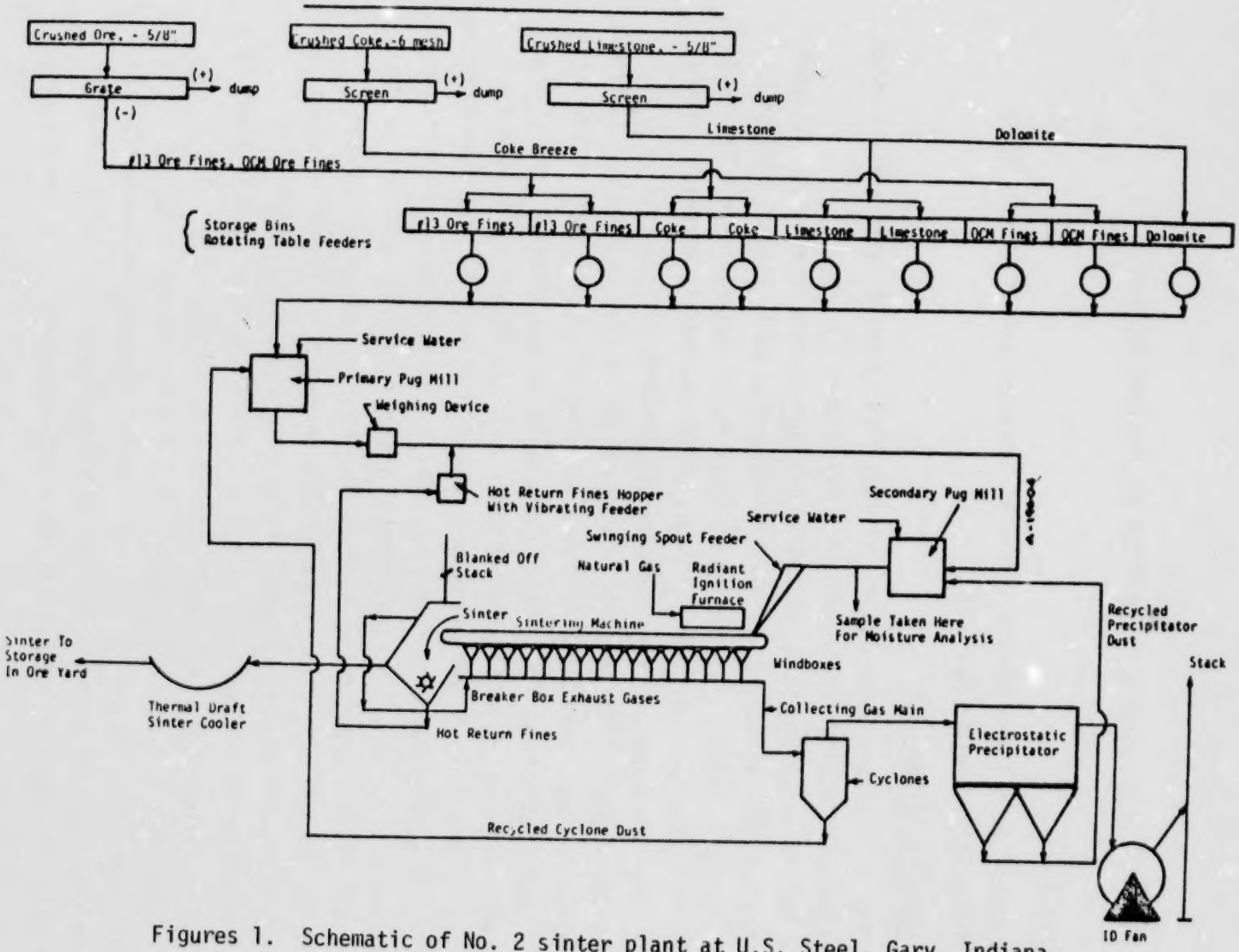
The plants tested were the No. 2 and No. 3 sinter plants at U.S. Steel Corporation's Gary, Indiana facility.

4.1.1. Number 2 Sinter Plant

The No. 2 sinter plant has two strands (Nos. 3 and 4) with a total rated sinter capacity of approximately 2900 tons/day (Figure 1).

The feed material for this plant does not contain any revert material such as steelmaking dust, cinder, slag, blast furnace flue dust, sludge, borings, turnings, and mill scale. Elimination of these revert materials from the feed mix tends to reduce the amount of particulate and condensible material emitted from the sintering process. The feed material consists of fluxes (24.5 %/wt limestone and 13 %/wt dolomite), iron ore fines (28.75 %/wt each of No. 13 fines from the Mesabi range and QCM fines from a Canadian mine), and fuel (5 %/wt coke breeze). Hot return fines from the sinter breaker at the discharge end of the sinter machine are recycled to a hopper which adds the return fines to the top of the sinter mix as it leaves the primary pug mill after the total feed weighing device. Particulates captured in the cyclones and electrostatic precipitator from the windboxes of the sintering machine are recycled (cyclone dust to the primary pug mill and precipitator dust to the secondary pug mill). Water is added to the pug mills to produce a raw sinter mix with the proper moisture content. This water is service water and not recycled process water. No special additives are in the sinter mix. The sinter produced at this plant is a superfluxing sinter with a basicity (ratio of $\{CaO + MgO\}/\{SiO_2 + Al_2O_3\}$) of 2.0 although basicity can vary depending on the blast furnace needs.

Each strand has its own set of feed material storage bins except for the dolomite storage bin. Each storage bin is equipped with a rotating table feeder which delivers the appropriate amount of feed material to the conveyor



Figures 1. Schematic of No. 2 sinter plant at U.S. Steel, Gary, Indiana

belt. There is no device to actually weigh the amount of each feed material that is added to the belt (occasional pan tests determine feed rate). The proper amounts of ore fines, flux, and coke breeze, after being added to the conveyor belt, are partially mixed by transfer from one conveyor belt to another. This mixture of feed materials then enters the primary pug mill where service water is added to adjust the moisture content and to thoroughly mix the feed materials with recycled dust caught by the cyclones that clean the windbox gases. At this point, a weighing device determines the weight of the mix on the belt. Hot return fines from the sinter breaker are added to a groove (created by a paddle) on top of the mix. There is no device to determine the percent by weight of return fines added to the mix. The mix and hot return fines then enter the secondary pug mill where service water is added to adjust the moisture content and to thoroughly mix these feed materials with recycled dust caught by the electrostatic precipitator that further cleans the gases leaving the cyclone dust collectors. Every two hours an operator takes a sample of this raw sinter mix to measure its moisture content, insuring that the proper amount of moisture has been added to the mix.

The raw sinter mix is then fed from a swinging spout feeder onto the moving pallets or grates of the strand. The sinter bed then enters the ignition furnace. The radiant hood ignition furnace ignites the coke breeze on the surface of the sinter bed and, as the bed moves along the traveling grate, air is pulled down through the bed to burn the fuel by downdraft combustion. The radiant furnace is always fired on natural gas. As the pallets move over the windboxes toward the discharge end of the strand, the burning zone moves deeper into the bed. The speed of the traveling grates (9 ft/min) is controlled by observing the quality of the sinter leaving the stand and monitoring the waste gas temperature in the windboxes. Every two hours an operator takes a sample of the sinter and performs a basicity test to insure that the proper grade of sinter is being produced. Another sample of the cooled sinter is analyzed to determine its size distribution. The sinter size should be 65 percent greater than 3 mesh.

At the discharge end, the sinter falls off the strand into a sinter breaker. The oversized sinter is then cooled in the rotating thermal draft cooler, dumped

onto a conveyor belt and transported to a storage pile in the ore yard. The hot fines from the breaker are transported to a hot returns hopper equipped with a vibrating feeder. These fines are returned to the process as described previously. Neither the breaker nor the sinter cooler has a separate air pollution control device. Emissions from the breaker box are exhausted to the windboxes but the collection efficiency of this system is marginal.

The windbox gases and particulates enter a gas main under the sintering machine and are transported to cyclone separators which remove the large particles. The effluent from the cyclones enters an electrostatic precipitator for final particulate removal. The cyclone dust is recycled to the primary pug mill, and the electrostatic precipitator dust is recycled to the secondary pug mill. The cleaned gas is then exhausted to the atomosphere through an ID fan and a stack.

4.1.2 Number 3 Sinter Plant

The basic operation of No. 3 sinter plant is similar to that of No. 2 sinter plant except the feed material does contain revert material.

The No. 3 sinter plant at Gary includes three sinter strands, two 6 feet wide and one 8 feet wide. The two 6 foot strands are Dwight-Lloyd, (1254 ft^2) and the 8 foot strand is by Dravo-Lurgi (1294 ft^2). The design production rates are 5,000 tons per day for each line, although 4,000 tons/ day is more common. Sinter basicity is about 1.2. Blast furnace sludge, ore, mill scale, and sinter fines are all used as feed. The conveyor belts are fed from table feeders. Some of the feeders have gravimetric control, and the others require manual calibration. The plant does not use a hearth layer. The strand is natural gas-fired under a radiant hood. A refractory heat retainer follows the ignition hood over the strand. Most of the first half of the strand is covered with a hood which is fed air from one of the fans on the circular sinter cooler as a heat conservation recycle to the windbox. Gas recycle was 15 to 20 percent of sinter cooler gas flow. The plant utilizes a sinter breaker, hot screening, a circular cooler, and cold screening.

Windbox emissions are controlled by electrostatic precipitators, one for each sinter line. The ESP's were original equipment (Koppers design) for the shop, dating about 1958. The precipitators each have had a general rebuild over the last several years. Gas flow per line is 10,194 acmm at 177°C (360,000 acfm at 350°F). A policeman is used ahead of the ESP. The ESP hoppers are emptied with a chain conveyor.

The discharge end gases are cleaned in baghouses, one per strand. The baghouses were designed by Gary Works and built by American Bridge in the late 1960's. Each baghouse includes 10 compartments of 88 bags each. Each bag is 29.21 cm (11 1/2 in.) in diameter, 9.14 meters (30 ft) long, and is set on 35.6 cm (14 in.) centers with two bag reach from the aisles. Design flow rates are 4,858 acmm at 127°C (171,550 acfm at 261°F) each and includes the discharge end of the line, the hot sinter conveyor, the hot screen, and the entry portions of the sinter cooler. The cleaning mechanism for the bags is reverse air, and the bag fabric is silicone treated fiberglass. The cleaning cycle for a compartment occurs about once per hour, and consists of venting the clean side (outside) of the bags to atmospheric pressure, causing the bags to collapse. This collapse cycle is repeated three more times in rapid succession. The dust drops by gravity to the hopper, through dust valves, and, periodically, by gravity chute to a conveyor belt. There is a cold screening station which is also controlled with a fabric filter.

During the Level 1 sampling test at No. 3 sinter plant, the following raw materials were being used to make sinter:

Revert Blend (90 tons/hr)	
Roll Scale	17 tons/hr
Sludge	17 tons/hr
#13 Ore Fines	35 tons/hr
Cold BOF Slag	17 tons/hr
Cold Scrap	4 tons/hr
QCM Ore Fines	60 tons/hr
Dolomite	9 tons/hr
Limestone	16 tons/hr
Coke	9 tons/hr

Cold Fines	54 tons/hr
Hot Fines	75 tons/hr
Total Mix	313 tons/hr

Level 1 sampling was conducted in the ductwork prior to the air pollution control equipment on the uncontrolled windbox particulate and gaseous emissions at both sinter plants.

4.2 SAMPLING

All components of the sampling equipment had been calibrated by Acurex prior to testing at U.S. Steel. The solvents used were Mallinckrodt Nanograde reagents. The 30 percent H_2O_2, ammonium persulfate, and silver nitrate were Mallinckrodt Analytical Grade reagents. The XAD-2 resin and SASS train components were cleaned and samples recovered by Level 1 procedures. Care was taken throughout these operations to prevent contamination. Figure 2 is a flow scheme showing the steps taken for the sampling and Figures 3 and 4 show the sample recovery procedures.

Prior to the SASS tests, preliminary velocity and temperature traverses of the ducts to be tested were made to determine an approximate sampling nozzle size. Static pressure measurements were also made because the ducts were under significant negative pressure (i.e., upstream of the air pollution control equipment and ID fan). Based on preliminary measurements of velocity pressure ~ 2.6 mmHg (1.4 in. water), stack gas temperature of 185°C (365°F), and static pressure of 37.4 mmHg (20 in. water), a nozzle size of 12.65 mm (0.4980 in.) was selected for the test (exact nozzle size of 12.95 cm (0.5100 in.) being unavailable.

Sampling at both the No. 2 and No. 3 sinter plants took place in the gas main after the windboxes and before pollution control equipment. A 7.6 cm (3 in.) diameter nipple had been welded into place on each duct to allow access for the SASS probe.

Sampling was conducted at a single point in the duct (no traverse) using a flowrate through the SASS train of about 0.11 scmm (4 scfm) to insure proper separation of the sampled particulates in three cyclones. The sampling probe and the oven containing the cyclones and filter holder were maintained at 204°C

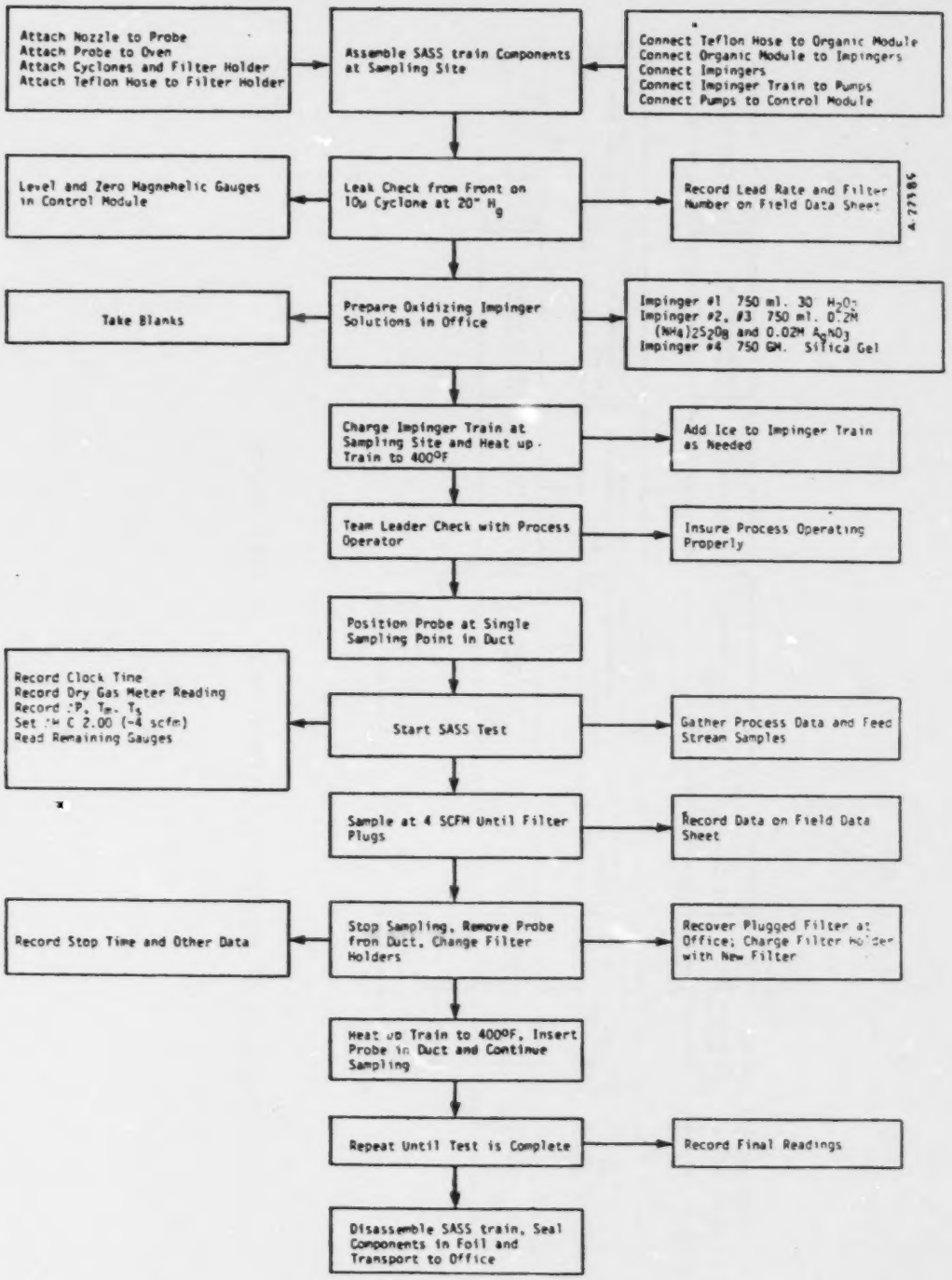

Attach Nozzle to Probe
Attach Probe to Oven
Attach Cyclones and Filter Holder
Attach Teflon Hose to Filter Holder
Assemble SASS train Components at Sampling Site
Connect Teflon Hose to Organic Module
Connect Organic Module to Impingers
Connect Impingers
Connect Impinger Train to Pumps
Connect Pumps to Control Module
Level and Zero Magnehelic Gauges in Control Module
Leak Check from Front on 10μ Cyclone at 20" Hg
Record Lead Rate and Filter Number on Field Data Sheet
A-27785
Take Blanks
Prepare Oxidizing Impinger Solutions in Office
Impinger #1 750 ml. 3% H2O2
Impinger #2, #3 750 ml. 0.2M (NH4)2S2O8 and 0.02M AgNO3
Impinger #4 750 GM. Silica Gel
Charge Impinger Train at Sampling Site and Heat up Train to 400°F
Add Ice to Impinger Train as Needed
Team Leader Check with Process Operator
Insure Process Operating Properly
Position Probe at Single Sampling Point in Duct
Record Clock Time
Record Dry Gas Meter Reading
Record ΔP, Tm, Ts
Set ΔH @ 2.00 (~4 scfm)
Read Remaining Gauges
Start SASS Test
Gather Process Data and Feed Stream Samples
Sample at 4 SCFM Until Filter Plugs
Record Data on Field Data Sheet
Record Stop Time and Other Data
Stop Sampling, Remove Probe from Duct, Change Filter Holders
Recover Plugged Filter at Office; Charge Filter Holder with New Filter
Heat up Train to 400°F, Insert Probe in Duct and Continue Sampling
Repeat Until Test is Complete
Record Final Readings
Disassemble SASS train, Seal Components in Foil and Transport to Office

Figure 2. SASS train sampling procedures

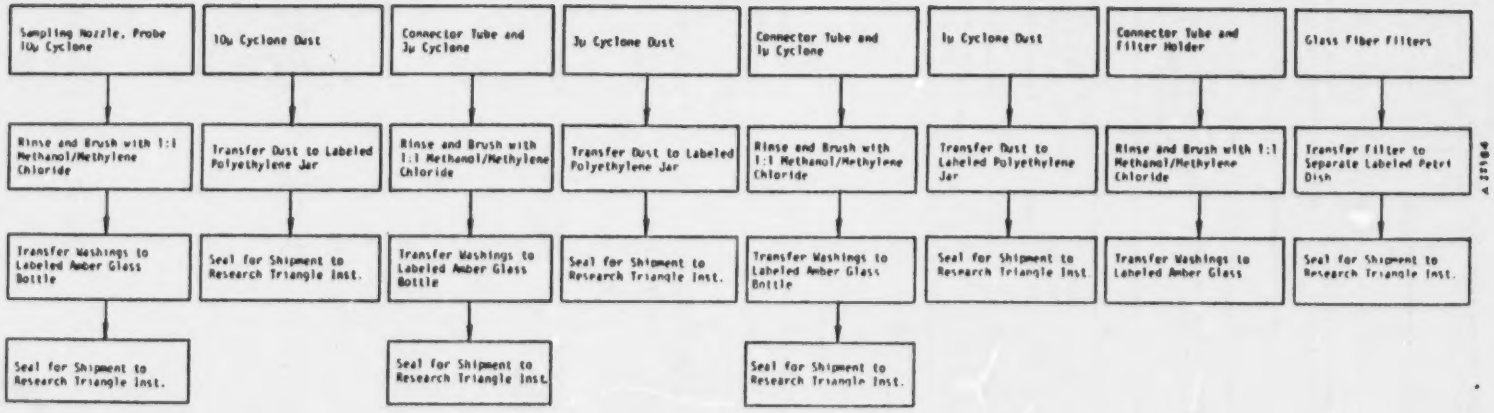
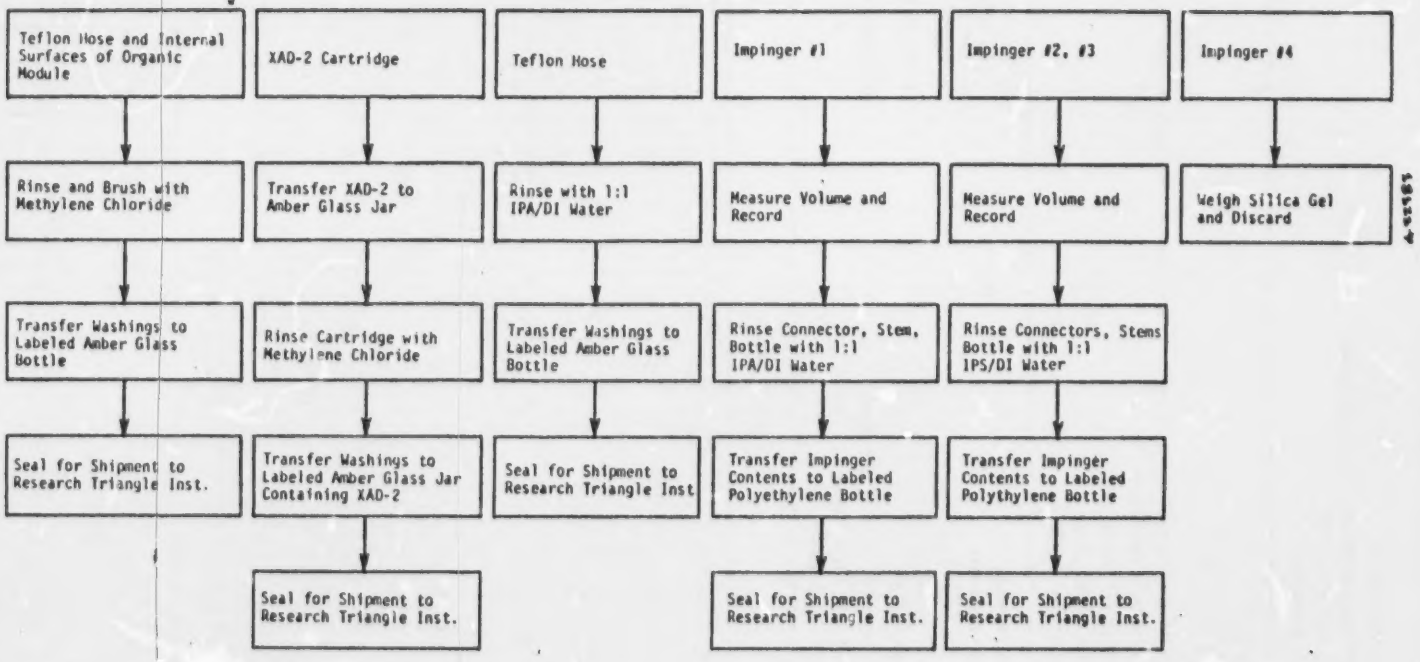

Sampling Nozzle, Probe 10μ Cyclone
10μ Cyclone Dust
Connector Tube and 3μ Cyclone
3μ Cyclone Dust
Connector Tube and 1μ Cyclone
1μ Cyclone Dust
Connector Tube and Filter Holder
Glass Fiber Filters
Rinse and Brush with 1:1 Methanol/Methylene Chloride
Transfer Dust to Labeled Polyethylene Jar
Rinse and Brush with 1:1 Methanol/Methylene Chloride
Transfer Dust to Labeled Polyethylene Jar
Rinse and Brush with 1:1 Methanol/Methylene Chloride
Transfer Dust to Labeled Polyethylene Jar
Rinse and Brush with 1:1 Methanol/Methylene Chloride
Transfer Filter to Separate Labeled Petri Dish
Transfer Washings to Labeled Amber Glass Bottle
Seal for Shipment to Research Triangle Inst.
Transfer Washings to Labeled Amber Glass Bottle
Seal for Shipment to Research Triangle Inst.
Transfer Washings to Labeled Amber Glass Bottle
Seal for Shipment to Research Triangle Inst.
Transfer Washings to Labeled Amber Glass
Seal for Shipment to Research Triangle Inst.
Seal for Shipment to Research Triangle Inst.
Seal for Shipment to Research Triangle Inst.
Seal for Shipment to Research Triangle Inst.
A 39184

Figure 3. Recovery of samples from front half of SASS train.


Teflon Hose and Internal Surfaces of Organic Module
XAD-2 Cartridge
Teflon Hose
Impinger #1
Impinger #2, #3
Impinger #4
Rinse and Brush with Methylene Chloride
Transfer XAD-2 to Amber Glass Jar
Rinse with 1:1 IPA/DI Water
Measure Volume and Record
Measure Volume and Record
Weigh Silica Gel and Discard
Transfer Washings to Labeled Amber Glass Bottle
Rinse Cartridge with Methylene Chloride
Transfer Washings to Labeled Amber Glass Bottle
Rinse Connector, Stem, Bottle with 1:1 IPA/DI Water
Rinse Connectors, Stems Bottle with 1:1 IPS/DI Water
Seal for Shipment to Research Triangle Inst.
Transfer Washings to Labeled Amber Glass Jar Containing XAD-2
Seal for Shipment to Research Triangle Inst
Transfer Impinger Contents to Labeled Polyethylene Bottle
Transfer Impinger Contents to Labeled Polythylene Bottle
Seal for Shipment to Research Triangle Inst.
Seal for Shipment to Research Triangle Inst.
Seal for Shipment to Research Triangle Inst.

*No condensate collected in glass condensate jar.

Figure 4. Recovery of samples from back half of SASS train.

Re Punch	PLANT	U.S. Steel, Gary
	LOCATION	ESP Inlet #3 Sinter Plant #2 Strand
	STACK DIAMETER (IN.)	9" - 9.75"
	DUCT DIMENSIONS (IN.) X (IN.)	
4.01	DATE	6-26-78
	TIME	1313
	RUN	SASS
4.02	OPERATORS	Gilchrist, Heffernan
4.03	STATIC PRESSURE (IN.WG.)	-29.0
	AMBIENT PRESSURE (IN.HG.)	29.29
	TYPE S PITOT COEFFICIENT	.778
4.07	STACK PRESSURE (IN.HG.)	27.16
	MOLECULAR WEIGHT (LB/LB-MOLE)	
	B_{wo}	
		IS-142-030 IS-142-035
		IS-142-029 IS-142-033
		IS-142-007 IS-142-031
		IS-142-009 IS-142-026
4.05	METER BOX NUMBER	0015
	ORIFICE METER COEFFICIENT	3.74 α = 0.96
	PROBE LENGTH (FT.)	5' Glass lined
	NOZZLE DIAMETER (IN.)	0.4980"
	FILTER NUMBER	
	LEAK RATE	0.045 @ 21" H_g

PARTICULATE SAMPLING DATA

		Sampling Point Number	Clock Time	Stack Gas Temp (°F)	Probe Temp (°F)	Impinger Outlet Temp (°F)	Oven Temp (°F)	Dry Gas Meter Temp Inlet (°F)	Dry Gas Meter Temp Outlet (°F)	Velocity Head (in. wg.)	Orifice Meter (in. wg.)	Gas Meter Volume (ft.³)	Pump Vacuum (in. Hg.)
Filter 1	10 min	2.5	1313	338	396		401	98	97	1.2	2.0	035.800	14/17
				343	398		399	101	98	1.3	2.2	054.84	17/20
				X	X	X	X	X	X	X	X	075.334	X
Filter 2	7 min		1342	355	412		401	101	100	1.2	2.2	075.334	16/19
				338	406		402	104	101	1.2	2.2	096.36	20/21
				X	X	X	X	X	X	X	X	104.765	X
Filter 3	7 min			315	400		406	104	104	1.1	2.2	104.765	16/19
				305	400		405	106	105	1.1	2.2	126.95	20/21
				X	X		X	X	X	X	X	134.199	X
Filter 4	4.3 min			348	395		401	105	107	1.2	2.2	134.199	15/18
				X	X		X	X	X	X	X	152.715	X
	4.0 min			298	400		407	107	107	1.1	2.2	152.715	20/21
				X	X	X	X	X	X	X	X	169.300	X
Filter 5	9.0 min			295	392		400	107	108	1.0	2.2	169.300	16/19
				298	395		402	107	108	1.2	2.2	190.89	20/21
				X	X	X	X	X	X	X	X	207.662	X
Filter 6	6.45 min			245	405		401	108	109	1.0	2.2	207.662	16/19
				245	395		402	110	109	1.1	2.2	229.27	20/22
				X	X	X	X	X	X	X	X	235.332	X
	3.0 min			241	399		403	111	110	1.2	2.2	235.332	19/21
				X	X	X	X	X	X	X	X	247.565	X
Filter 7	7.0 min			243	406		402	106	108	1.2	2.2	247.565	17/20
				239	394		599	106	108	1.1	2.2	269.16	20/21
Filter 8	7.0 min			262	405		397	106	107	1.0	2.2	277.392	17/20
				272	393		397	107	107	1.0	2.2	299.07	20/22
												307.120	
				Average				Average	Average				
EOF				291.7				Average	105.5		Average 2.2	Total 271.32	

$\sqrt{\Delta P}$ = 1.056

Figure 5. Sampling data for SASS test at No. 3 sinter plant.

Re Punch	PLANT U.S. Steel, Gary, Indiana LOCATION Main Windbox Gas Main Before Cyclones #2 Sinter Plant STACK DIAMETER (IN.) DUCT DIMENSIONS 120 in. x 120 in.
4.01	DATE 6/22/78 TIME 4:30 pm RUN SASS
4.02	OPERATORS Knirck, Gilchrist
4.03	STATIC PRESSURE (IN.HG.) -20.0 AMBIENT PRESSURE (IN.HG.) 29.46 TYPE S PITOT COEFFICIENT 0.778
4.07	STACK PRESSURE (IN.HG.) 28.02 MOLECULAR WEIGHT (LB/LB-MOLE) B_{wo}
4.05	METER BOX NUMBER 0015 ORIFICE METER COEFFICIENT 3.74 α = 0.96 PROBE LENGTH (FT.) 5' glass lined NOZZLE DIAMETER (IN.) 0.4980

178-95
-96
-04
-36
142-024
FILTER NUMBER
LEAK RATE

PARTICULATE SAMPLING DATA

Sampling Point Number	Clock Time	Stack Gas Temp (°F)	Probe Temp (°F)	Impinger Outlet Temp (°F)	Oven Temp (°F)	Dry Gas Meter Temp Inlet (°F)	Dry Gas Meter Temp Outlet (°F)	Velocity Head (in. wg.)	Orifice Meter (in. wg.)	Gas Meter Volume (Ft.³)	Pump Vacuum (in. hg.)
Mid-point	4:38	330		77	400	76	74	1.60	2.10	768.520	16
		335			395				2.10	808.000	20
Stop to change filter →	4:52	330		77	397	79	76	1.60	2.00	817.78	22
	5:22	290			400	78	76	1.60	2.10	817.78	18
						83	77		2.00	838.50	18
		300		78		84	78	1.60	2.00	859.00	
Stop to change filter → 4.04	5:33								1.90	865.115	22
	6:14	313			400	76	76	1.60	2.05		15
		301			300	82	77	1.55	2.00	885.5	18
		320			245	85	78	1.55	2.00	906.1	20
Stop to change filter →	6:27									914.485	
	6:55	335			400	77	77	1.60	2.00	914.485	15
		345			295	79	77	1.55	1.95	934.90	16
		292			250	85	78	1.55	1.90	955.35	18
Stop to change filter →	7:10									977.035	21
	7:57	268			400	77	77	1.65	1.85	977.035	15
		275				82	78	1.65	1.90	997.15	16
		302			210	86	79	1.55	1.90	1017.25	19
	8:11					86	80			1134.695	21
	66 min	Average 310				Average	Average		Average 1.93	Total 355.175	

EOT

$\sqrt{\Delta P}$ = 1.26

Figure 6. Sampling data for SASS test at No. 2 sinter plant.

(400°F) which was considerably above the stack gas temperature at both locations. The XAD-2 cartridge was maintained at 15.6°C (60°F) and the impinger temperature varied between 21 and 26.7°C (70 and 80°F).

Prior to and during the course of the test, one member of the crew made sure that the strand was operating and recorded process operating data. During the run, sampling data were recorded on field data sheets (Figures 5 and 6). Because of the heavy particulate matter concentration of < 1 μ size in the windbox gases, several filter changes were required during each SASS test. Although normal Level 1 procedure is to collect about 30 m^3 (1000 ft^3) of gas, this volume was not collected in either test due to the excessive number of filter changes (five and eight) required and the excessive time needed to raise the oven temperature to 204°C (400°F) after each filter change. Minimum volume collected was 7.3 dscm (260 dscf). Raw feed samples were obtained for both sinter strands.

5.0 TEST RESULTS

5.1 ON-SITE RESULTS

The Acurex Corporation acquired the data at the sampling sites (Tables 3 and 4). Sampling rates were near isokinetic for both tests (120 percent in Series 1--No. 3 plant and 134.7 percent in Series 2--No. 2 plant). In neither case was the 30 m^3 (1000 ft^3) sample recommended by Level 1 procedures obtained. High particulate grain loadings in the uncontrolled windbox gases consistently plugged the 1 μ filter at about 9 minute intervals. Thirty to forty minutes were required to change the filter and reheat the cyclone oven to the Level 1 prescribed 204°C (400°F). Total sampling time for either location was in excess of one hour, with a minimum of 7.3 m^3 (260 ft^3) of sample taken.

No on-site gas analyses for low molecular weight organics or inorganic species were made.

5.2 ANALYSIS OF SASS TRAIN SAMPLES

Data presented in this section are the results of analyses performed by Research Triangle Institute. Figures 7 and 8 show the analysis procedure used for each sample.

5.2.1 Total Particulate Loading

The total mass of particulates in the sinter plant windbox gases (before the control devices) and their concentration is given in Table 5. For sinter plant No. 3 (processing revert material, Series 1) 79 percent of the particulate is greater than 3 μ in size. Over 12 percent of the particulate was captured by the < 1 μ filter. For the sinter plant not processing revert material (No. 2, Series 2), 86 percent of the captured dust was over 3 μ in size. About 6 percent of the particulate matter was captured on the < 1 μ filter.

TABLE 3. SUMMARY OF SAMPLING DATA FOR NO. 2 SINTER PLANT U.S. STEEL, GARY, INDIANA

Date of Test:	6/22/78
Volume of Gas Sampled:	371.173 dscf
Stack Gas Temperature:	310°F
Stack Gas Pressure:	28.02 inches Hg
Stack Gas Dry Molecular Weight:	29.18 lb/lb-mole
Stack Gas Wet Molecular Weight:	28.93 lb/lb-mole
Stack Gas Moisture:	2.2%
Stack Gas Velocity:	81.7 ft/sec (single point)
Stack Gas Flowrate:[a]	242714 dscfm[a]
Total Sampling Time:	66 minutes
SASS Train Flowrate:	5.62 dscfm
% Isokinetic:	134.7

[a]Average flowrate measured during 3 compliance tests at ESP outlet was 153766 dscfm.

TABLE 4. SUMMARY OF SAMPLING DATA FOR NO. 3 SINTER PLANT U.S. STEEL, GARY, INDIANA

Date of Test:	6/26/78
Volume of Gas Sampled:	260.666 dscf
Stack Gas Temperature:	292°F
Stack Gas Pressure:	27.16 inches Hg
Stack Gas Dry Molecular Weight:	28.96 lb/lb-mole
Stack Gas Wet Molecular Weight:	28.22 lb/lb-mole
Stack Gas Moisture:	6.7%
Stack Gas Velocity:	69.5 ft/sec (single point)
Stack Gas Flowrate	18441 dscfm
Total Sampling Time:	64.75 minutes
SASS Train Flowrate:	4.02 dscfm
% Isokinetic:	120

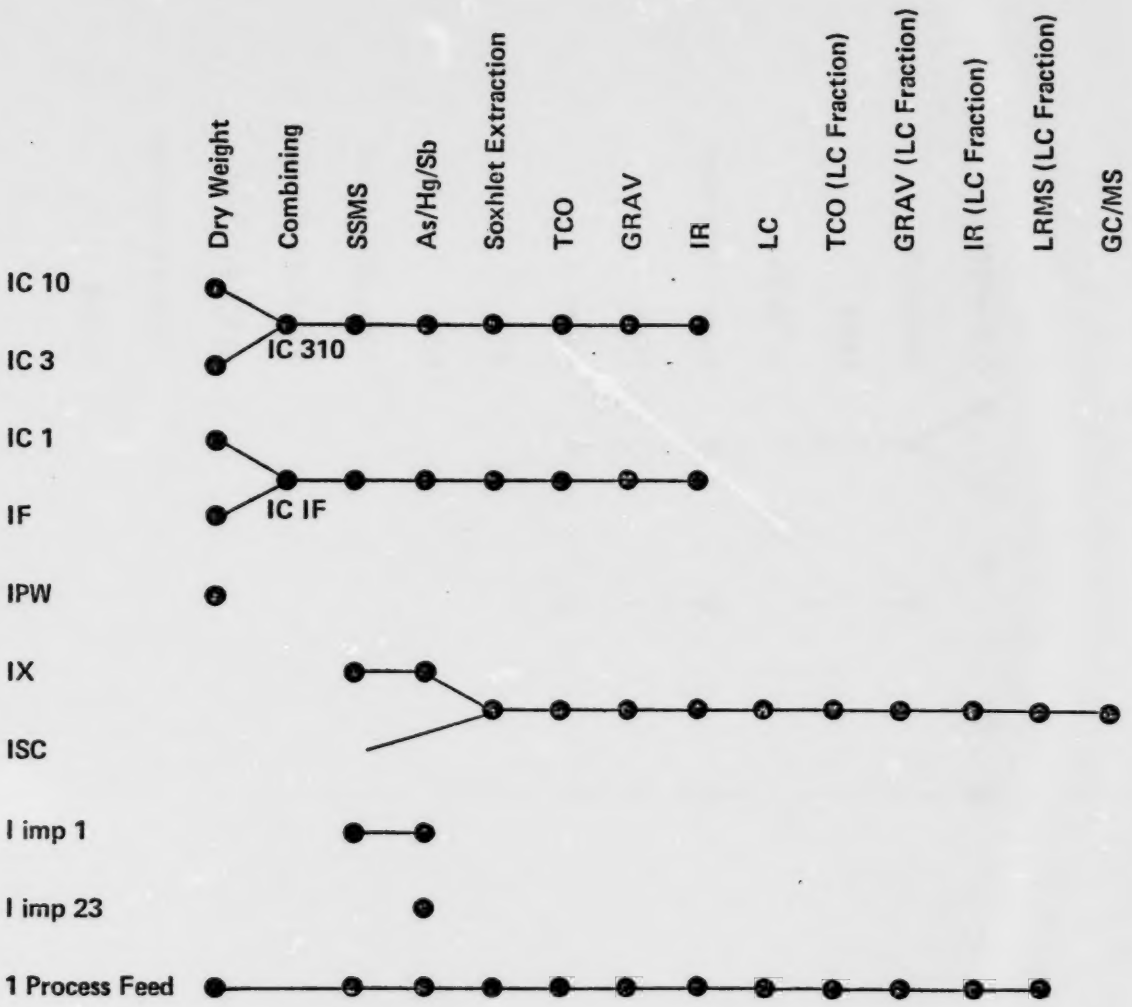


Figure 7. Analytical Procedures for Sinter Plant No. 3.

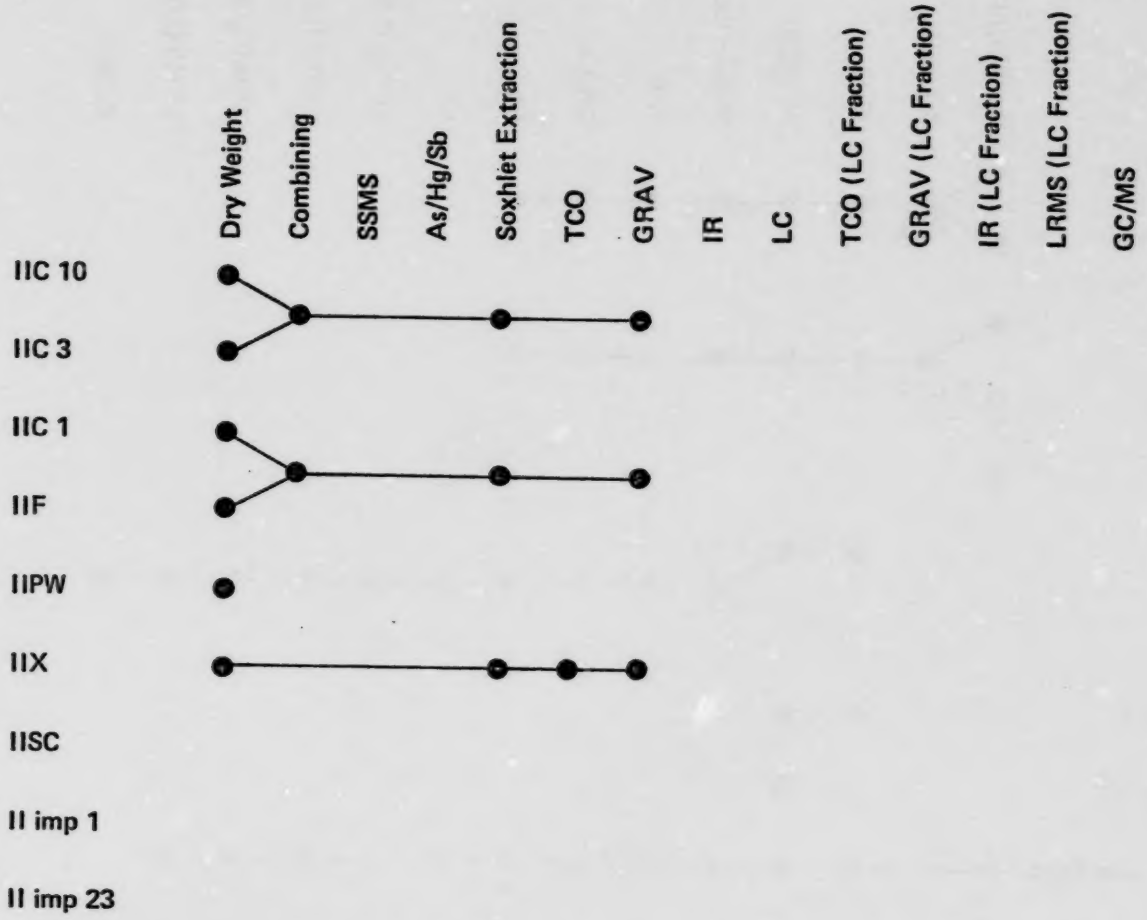


Figure 8. Analytical Procedures for Sinter Plant No. 2.

TABLE 5. TOTAL MASS OF EMITTED PARTICLES

Test Series No.	2	1
Plant No.	2	3
Sample Point	Windbox gas main before the cyclones	
Volume of gas sampled	10.510 m^3	7.381 m^3
TOTAL PARTICULATE		
10 μ cyclone	6.2700 gms	5.8654 gms
3 μ cyclone	0.9789	2.2865
1 μ cyclone	0.5533	0.7235
Filter	0.4921	1.3027
Probe and cyclone rinses	0.1512	0.1956
TOTAL	8.4455	10.3737
TOTAL CONCENTRATION, mg/m^3		
10 μ cyclone	597	795
3 μ cyclone	93	310
1 μ cyclone	53	100
Filter	47	175
Probe and cyclone rinses	14	25
TOTAL	804 mg/m^3	1,405 mg/m^3

The total particulate loading for sinter plant No. 2 was 804 mg/m^3 while sinter plant No. 3 particulate concentration was 1,405 mg/m^3. It is interesting to note that the plant processing revert material contains a larger fraction of submicron particulates.

5.2.2 Level 1 Organic Analysis

Total organic material extracted from the various SASS train components for both test runs is summarized in Table 6. Low, but not insignificant amounts of organic matter were found in the sinter plant No. 3 particulates. About 87 percent of the total organic material was found in the XAD-2 extract, 78 percent of which falls into the GRAV range (high boiling point material).

TABLE 6. TOTAL EXTRACTABLE ORGANICS, mg/m^3

Test Series	1	2
Process	Sinter Plant No. 3	Sinter Plant No. 2
PARTICULATE EXTRACTS		
10 + 3 μ	0.15	0.38
1 + Filter	0.99	0.29
Probe + Cyclone Rinses	2.17	2.38
XAD-2	22.35	1.79
Process Feed Sample	179.9 mg/Kg	

Total organic emissions in the windbox are about 16 percent of the organic in the feed material.

Calculation:

25.66 mg/m^3 organics in emission
320,150 m^3/hr gas flow (313 ton feed/hr)
1,023 m^3/ton of feed material
26,246 mg/ton feed
179.9 mg organic/Kg feed material
163,241 mg organic/ton feed

$$\frac{25.66\ mg/m^3 \times 1023\ m^3/ton\ feed}{179.9\ mg/Kg\ feed \times 907.4\ kg/ton} = 0.16.$$

Substantially lower organic emissions were found from sinter plant No. 2 (no revert material). Although organics contained in the particulates are not substantially different for the two runs, a ten-fold decrease in organics captured by the XAD-2 resin was found. Since samples from sinter plant No. 2 were not received by RTI until two months after sampling, there is a possibility that some loss or degradation of the organic material occurred. Because most of the recovered material in the XAD-2 resin from both runs was GRAV (high boiling) organics, it is not believed that a loss of this magnitude could have occurred.

Level 1 analysis procedures recommend subjecting each SASS extract containing more than 0.5 mg/m^3 of total organics to a liquid chromatography (LC) fractionation. For a 30 m^3 sample this amounts to a minimum of 15 mg of organic sample, which is the minimum size for which a good LC separation can be done. No samples containing less than 15 mg of organic matter was subjected to LC even though less than 30 m^3 of sample was collected. Using this criteria, only the process feed and the XAD-2 SASS samples required LC workup. Both extracts were taken through LC separations, and the seven LC fractions from each were analyzed for TCO and GRAV as well as by IR and LRMS. The LC, IR, and LRMS data are given in the Appendices. From these data the organic species in each extract were classified into compound categories and the concentration of each category estimated. Concentration estimates are based on GRAV material only since the procedures used removed TCO before IR or LRMS spectra were obtained. Strong peaks in the IR and LRMS were assigned intensity factors of 100; weak and very weak peaks were assigned intensitites of 10. The GRAV concentration in mg/m^3 was then apportioned to each compound category according to its intensity factor such that the sum for all categories in a specific LC fraction equalled the GRAV concentration for that fraction. Tables 7 and 8 show these results for sinter plant No. 3 and Table 9 is a comparison of the organic extracts. No LC work was done on the sinter plant No. 2 samples because of their uncertain history. Regardless of the results that might have been obtained, the results could have been attributed to sample degradation and were, therefore, not deserving of complete analysis.

Interesting aspects of the data are:

1. Aliphatic hydrocarbons are shown to be the predominate category in both feed material and sinter emissions (1X).
2. Substituted benzenes and fused aromatics are the second major category. Over 50 percent of the fused aromatics have molecular weights greater than 216. Carcinogenic material usually has molecular weights above 216.
3. Compound categories in the sinter emission are in about the same relative proportion as the categories in the raw feed (Table 9).
4. The LRMS data (Appendix A) contains several molecular weights associated with known carcinogens.

TABLE 7. ORGANIC EXTRACT SUMMARY TABLE

Sample 1X --XAD-2 Resin and Module Rinse

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3	8.16	4.24	0.69	0.73	0.22	2.03	0.16	16.23
TCO, mg	24.0	16.7	0.6	2.6	0.0	6.9	0.0	50.8
GRAV, mg	36.2	14.6	4.5	2.8	1.6	8.1	1.2	69

Category	Int/mg/m^3 (Based on GRAV only)							
Aliphatics	100/4.5	--						4.5
Halo aliphatics	10/0.4	10/0.09						0.49
Subst. Benzenes		100/0.9	100/0.29					1.19
Halo Benzenes		10/0.09	10/0.03					0.12
Fused Aromatics		100/0.9	100/0.29					1.19
Hetero N Cmpds				100/0.09	100/0.03	100/0.2	100/0.06	0.38
Hetero O Cmpds				100/0.09	100/0.03			0.12
Hetero S Cmpds				100/0.09	100/0.03			0.12
Alkyl S Cmpds					10/0.003	10/0.02	10/0.006	0.029
Nitriles				10/0.01	10/0.003			0.013
Aldehydes, Ketones				100/0.09	100/0.03			0.12
Nitroaromatics				10/0.01	10/0.003			0.013
Ethers, Epoxides				10/0.01	100/0.03			0.04
Alcohols					10/0.003	100/0.2	10/0.006	0.209
Phenols					10/0.003	100/0.2	10/0.006	0.209
Amines					10/0.003	100/0.2	10/0.006	0.209

TABLE 7. (cont'd)

ORGANIC EXTRACT SUMMARY TABLE

Sample 1X

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3								
TCO, mg								
GRAV, mg								

Category	Int/mg/m^3 (Based on GRAV only)							
Amides					10/0.003	10/0.02	10/0.006	0.029
Esters					100/0.03	100/0.2	100/0.06	0.29
Carboxylic Acids						10/0.02	10/0.006	0.026
Sulfonic Acids and Sulfoxides						10/0.02	10/0.006	0.026

TABLE 8. ORGANIC EXTRACT SUMMARY TABLE

Sample Process Feed (No. 3 Plant)

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3	91.0	24.5	12.2	7.3	6.0	19.2	2.6	162.8
TCO, mg	1.0	1.6	0.6	0.0	0.0	0.4	0.0	3.6
GRAV, mg	54.0	13.2	6.8	4.4	3.6	11.2	1.6	94.8

Category	Int/mg/Kg (Based on GRAV only)							
Aliphatics	100/81.2							81.2
Halo aliphatics	10/8.1	10/1.0						9.1
Subst. Benzenes		100/10.0	100/5.2					15.2
Halo Benzenes		10/1.0	10/0.5					1.5
Fused Aromatics		100/10.0	100/5.2					15.2
Hetero N Cmpds				100/1.4	100/0.8	100/3.4		5.6
Hetero O Cmpds				100/1.4	100/0.8			2.2
Hetero S Cmpds				100/1.4	100/0.8			2.2
Alkyl S Cmpds					10/0.1	10/0.4		0.5
Nitriles				10/0.1	10/0.1			0.2
Aldehydes, Ketones				100/1.4	100/0.8			2.2
Nitroaromatics				10/0.1	10/0.1			0.2
Ethers, Epoxides				100/1.4	100/0.8			2.2
Alcohols					100/0.8	100/3.4	10/0.4	4.6
Phenols					100/0.8	100/3.4	10/0.4	4.6
Amines					100/0.8	100/3.4	10/0.4	4.6

TABLE 8. (cont'd)

ORGANIC EXTRACT SUMMARY TABLE

Sample _____

	LC1	LC2	LC3	LC4	LC5	LC6	LC7	Σ
Total Organics, mg/m^3								
TCO, mg								
GRAV, mg								

Int/mg/Kg (Based on GRAV only)

Category								
Amides					10/0.1	100/3.4	10/0.4	3.9
Esters					1 0.1	10/0.4	10/0.4	0.9
Carboxylic Acids						10/0.4	10/0.4	0.8
Sulfonic Acids and Sulfones						10.0.4	10/0.4	0.8
								157.7

TABLE 9. COMPARISON OF ORGANIC EXTRACTS FOR SINTER PLANT NO. 3

	LC1	LC2	LC3	LC4	LC5	LC6	LC7
TOTAL ORGANICS[a]							
Sample 1X	50.3	26.1	4.3	4.5	1.4	12.5	1.0
Process Feed	55.9	15.0	7.5	4.5	3.7	11.8	1.6
TCO							
Sample 1X	47.2	32.9	1.2	5.1	0	13.6	0
Process Feed	27.8	44.4	16.7	0	0	11.1	0
GRAV							
Sample 1X	52.5	21.1	6.5	4.1	2.3	11.7	1.7
Process Feed	57.0	13.9	7.2	4.6	3.8	11.8	1.7

Compound Category[b]	Process Feed	Sample 1X
Aliphatics	51.5	48.1
Halo Aliphatics	5.8	5.2
Substituted Benzenes	9.6	12.7
Halo Benzenes	1.0	1.3
Fused Aromatics	9.6	12.7
Hetero N Compounds	3.6	4.1
Hetero O Compounds	1.4	1.3
Hetero S Compounds	1.4	1.3
Alkyl S Compounds	0.3	0.3
Nitriles	0.1	0.1
Aldehydes, Ketones	1.4	1.3
Nitro Aromatics	0.1	0.1
Ethers, Epoxides	1.4	0.4
Alcohols	2.9	2.2
Phenols	2.9	2.2
Amines	2.9	2.2
Amides	2.5	0.3
Esters	0.6	3.1
Carboxylic Acids	0.5	0.3
Sulfonic Acids and Sulfoxides	0.5	0.3

[a]All data is in percent, calculated as follows: Total organics, TCO, and GRAV calculated by dividing the total mg/m^3 or mg found in each LC fraction (see Tables 8 and 9) by the sum of the LC fractions for that component.

[b]All data is in percent, calculated as follows: (see Tables 8 and 9), the sum of each compound category for each sample was divided by the sum of all compound categories for that sample.

In Table 10 the organic emissions from sinter plant No. 3 are compared to AIR-Health MATE values. The percent control potentially required is calculated for the sample actually analyzed (1X) and for the total organic emissions (assuming all the organic found has the same compound categories in the same proportion as sample 1X). The percent control in all cases was calculated using the lowest MATE value listed for the category.

5.2.3 GC-MS Analysis

One extract (1X) was subjected to GC-MS analysis for identification and quantification of potential carcinogenic compounds. The concentrated extract, before any LC separation, was used. Single ion current plots were obtained for m/e's 178, 202, 228, 252, 276, 278, and 302. All plots except 178 and 202 were blank, i.e., no mass associated with those m/e's. There are two possible explanations for the difference in the GC-MS and LRMS results. It is possible that the masses found in the LRMS are fragments of much higher molecular weight compounds. These high molecular weight compounds would not have eluted from the GC column, therefore, their fragmentation pattern would not appear in the GC-MS plot. This is the most likely explanation for m/e's 252 and 228 and is a possible explanation for the masses above 270.

The second possible explanation involves the capabilities of the GC-MS system and column as used. With the column and conditions used, low volatility compounds, like polynuclear compounds, above molecular weights of about 270 are eluted from the GC very poorly, if at all. Thus, it is possible that compounds having m/e's of 276, 278, and 302 (for example, indenopyrene, benzoperlene, dibenzoanthracene, and dibenzopyrene) were actually in the sample but not detected by the GC-MS. Most of these compounds are known to have carcinogenic properties.

Table 11 presents the GC-MS data, showing the four polycyclic aromatic hydrocarbons identified and the calculated concentration in the flue gas. None of these compounds are known to have carcinogenic properties.

TABLE 10. TOTAL EXTRACTABLE ORGANICS, SINTER PLANT NO. 3

Compound Category	AIR-Health Value-Range mg/m^3	Emission[a] Analyzed As Sample 1X, mg/m^3	% Control Potentially Required	Total[b] Organic Emissions mg/m^3	% Control Potentially Required
Aliphatics	500-10,000	4.5	0	12.4	0
Halo Aliphatics	0.1-7,000	0.49	0-80	1.35	0-93
Sub. Benzenes	1-600	1.19	0-16	3.28	0-70
Halo Benzenes	0.7-700	0.12	0	0.33	0
Fused Aromatics	$1x10^{-4}$-300	1.19	0-99.99[c]	3.28	0-99.99[c]
Hetero N Cmpds.	0.1-100	0.38	0-74	1.05	0-90
Hetero O Cmpds.	500	0.12	0	0.33	0
Hetero S Cmpds.	6-50	0.12	0	0.33	0
Alkyl S Cmpds.	0.9-90	0.03	0	0.08	0
Nitriles	2-80	0.01	0	0.028	0
Aldehydes, Ketones	0.4-3,000	0.12	0	0.33	0
Nitro Aromatics	1-300	0.01	0	0.028	0
Ethers, Epoxides	200-3,000	0.04	0	0.11	0
Alcohols	30-8,000	0.21	0	0.58	0
Phenols	3-200	0.21	0	0.58	0
Amines	0.1-80	0.21	0-52	0.58	0-83
Esters	8-800	0.29	0	0.80	0
Carboxylic Acids	0.5-300	0.03	0	0.08	0
Sulfonic Acids and Sulfoxides	0.8-200	0.03	0	0.08	0

TABLE 10. (cont'd)

[a]This column is the result of LC, IR, and LRMS analysis of sample 1X and is based on the GRAV weight only. This GRAV weight is 58 percent of the total organics in sample 1X and 36.3 percent of the total organics captured during the emissions test.

[b]This column is obtained by dividing the data in the column referred to in Note a by 0.363 (ratioing GRAV found in 1X to total organics found). The assumption made is that all TCO and GRAV material captured during the test is identical to the GRAV component of sample 1X. This is probably a poor assumption, especially for the TCO components, but it does allow an indication of the total emission level.

[c]Based on the most toxic or carcinogenic members of the category. No evidence for these compounds was found by GC-MS analysis.

TABLE 11. POLYCYCLIC ORGANIC COMPOUNDS, SAMPLE 1X

Compound	MW	Concentration, mg/m^3
Anthracene	178	0.254
Phenanthrene	178	0.042
Pyrene	202	0.128
Fluoranthene	202	0.146
d^{10}Anthracene (IS)	188	0.054

Ion Source Temperature	210°C		
Electron Energy	70 ev		
Trap Current	50 ma		
Acc. Voltage	3500 V	Multiplier Setting	425
Start Time	120	Interval Time	2.4
Column Name	1% SE-30 19M	Factor	0.0
Flow	2.54 ml/15.0 MU		
Inj. Temp.	265°C		
Column Temp.	Held at 100°C for 2 min then heated at 8°C/min to 265°C		
Sep. Temp.	275°C		

5.2.4 Inorganic Analysis

Atomic absorption analyses of samples from No. 3 sinter plant are presented in Table 12. Arsenic, antimony, and mercury appear to be contained almost exclusively in the particulate matter. Their emission from the sintering process will, therefore, depend on the efficiency of the particulate control equipment used.

TABLE 12. ARSENIC, MERCURY, AND ANTIMONY DETERMINATIONS BY ATOMIC ABSORPTION

Sample Code	As	Hg	Sb
	mg/m^3		
1 C1F	0.0142	0.00062	0.0111
1 C310	0.0133	0.00033	0.0206
1 X	ND	0.00247	ND
1 IMP 1	ND	ND	ND
1 IMP 23	ND	ND	ND
TOTAL	0.0275	0.00342	0.0317
		mg/Kg	
Process Feed	ND*	0.272	ND*

*The reason for As and Sb appearing in some samples but not in the feed sample is not readily apparent.

Spark Source Mass Spectrographic (SSMS) analyses of the sample are presented in Tables 13 through 18. Table 13 presents the total inorganics found. The original SSMS data for each sample are in Appendix A.

TABLE 13. TOTAL INORGANICS, SINTER PLANT NO. 3
SPARK SOURCE MASS SPECTROSCOPY DATA

Element	Health MATE Value or Range mg/m^3	At Source Mass/Volume mg/m^3 or $\mu g/L$	% Control Required
Copper	0.2	1.48	85.6
Nickel	0.015	0.038	60.5
Cobalt	0.050	0.0047	0
Iron	0.7 - 9.0	45.4	98.5-80.2
Manganese	5.0	7.93	37
Chromium	0.001	0.075	98.7
Vanadium	0.5	0.017	0
Titanium	6.0	0.233	0
Scandium			
Calcium	16.0	32.2	50
Potassium	2.0	5.77	65.4
Chlorine			
Sulphur	1.0 - 440	15.16	0-93.4
Phosphorus	0.1 - 1.0	3.08	96.8-67.5
Silicon	10	0.791	0
Aluminum	5.2 - 10	10.81	5.19-8
Magnesium	6 - 10	2.54	0
Sodium	2 -53	Major	?
Fluorine			
Oxygen			
Nitrogen			
Carbon			
Boron	3-10	0.117	0
Beryllium	0.002	0.0006	0
Lithium	0.022	0.006	0
Hydrogen			

TABLE 13. (cont'd)

Element	Health MATE Value or Range mg/m^3	At Source Mass/Volume mg/m^3 or $\mu g/L$	% Control Required
Cerium	37	0.006	0
Lanthanum	110	0.001	0
Barium	0.5	0.049	0
Cesium	82	0.0011	0
Iodine	UK	0.013	
Tellurium		0.0022	UK
Antimony	0.5	0.012	0
Tin	10	0.0045	0
Indium		IS	
Cadmium	0.010	0.0042	0
Silver			
Palladium			
Rhodium			
Ruthenium			
Molybdenum	5.0	0.0058	0
Niobium	22	0.00084	0
Zirconium	5.0	0.0049	0
Yttrium	1.0	0.0021	0
Strontium	3.1	0.037	0
Rubidium	120	0.064	0
Bromine	10	0.034	0
Selenium	0.2	<0.0056	0
Arsenic	0.002	0.0226	91.2
Germanium	0.56	0.0029	0
Gallium	0.50	0.0032	0
Zinc	4.0	1.20	0

TABLE 13. (cont'd)

Element	Health MATE Value or Range mg/m^3	At Source Mass/Volume mg/m^3 or $\mu g/L$	% Control Required
Uranium	0.009	<0.0009	0
Thorium	0.42	<0.004	0
Bismuth		0.0017	
Lead	0.150	0.657	77.2
Thallium		0.0062	?
Mercury			
Gold			
Platinum			
Iridium			
Osmium			
Rhenium			
Tungsten		0.005	
Tantalum			
Hafnium			
Lutecium			
Ytterbium			
Thulium			
Erbium			
Holmium			
Dysprosium			
Terbium			
Gadolinium			
Europium			
Samarium			
Neodymium		0.0014	
Praseodymium	51	0.00015	0

TABLE 14. SSMS ANALYSIS SHEET, 1C1F

Contractor: Research Triangle Institute

Sample Site: U.S. Steel, Gary, IN — Sample Acquisition Date: 6/26/78

Type of Source: Sinter Plant Windbox - before control device

Test Number: _____ — Sample ID Number: 1C1F

Sample Description: 1 μ Cyclone and Filter Particulates

Responsible Analyst: GCA — Date Analyzed: _____

Calculations and Report Reviewed By: _____ — Report Date: _____

Instrument: _____ — Resolution: _____

Internal Standard(s): Indium

Original Sample Volume or Mass: 2.0262 grams (at source)

Dilution Factor: 80.52

Brief Description of Electrode Preparation: _____

0.1021 grams 1 μ dust and 0.2084 gms of filter catch parr bombed and taken up in 25 ml of solution. 20 ml of solution used in test.

TABLE 14. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper							88.6	0.0243
Nickel							54.8	0.015
Cobalt							0.81	0.00022
Iron							20128	5.526
Manganese							475	0.130
Chromium							24.2	0.0066
Vanadium							5.39	0.0015
Titanium							31.4	0.0086
Scandium								
Calcium							16908	4.64
Potassium							17713	4.86
Chlorine								
Sulphur							5878	1.61
Phosphorus							242	0.066
Silicon							242	0.066
Aluminum							1610	0.442
Magnesium							5233	1.45
Sodium							M	
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron							354	0.097
Beryllium							0.70	0.0002
Lithium							14.5	0.004
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 14. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium							1.69	0.0005
Lanthanum							0.35	0.0001
Barium							10.5	0.0029
Cesium							0.056	0.00002
Iodine								
Tellurium							5.48	0.0015
Antimony							4.03	0.0011
Tin							3.30	0.00091
Indium							IS	
Cadmium							8.05	0.0022
Silver								
Palladium								
Rhodium								
Ruthenium								
Molybdenum							4.67	0.0013
Niobium							0.121	0.00003
Zirconium							1.21	0.00033
Yttrium							0.370	0.0001
Strontium							9.66	0.0027
Rubidium							209.3	0.058
Bromine							28.2	0.0077
Selenium							< 8.05	< 0.0022
Arsenic							8.86	0.0024
Germanium							0.75	0.00021
Gallium							0.60	0.0002
Zinc							128.8	0.035

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 14. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth								
Lead							3.22	0.0009
Thallium							2013	0.553
Mercury							22.5	0.0062
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten								
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium								
Neodymium								
Praseodymium								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank)

TABLE 15. SSMS ANALYSIS SHEET, 1C310

Contractor: Research Triangle Institute

Sample Site: U.S. Steel, Gary, IN Sample Acquisition Date: 6/26/78

Type of Source: Sinter Plant Windbox - before control

Test Number: Sample ID Number: 1C310

Sample Description: 3 μ and 10 μ Cyclone Catches

Responsible Analyst: GCA Date Analyzed:

Calculations and Report Reviewed By: Report Date:

Instrument: Resolution:

Internal Standard(s): Indium

Original Sample Volume or Mass: 8.1519 gms at source (0.0995 gm tested)

Dilution Factor: NEAT

Brief Description of Electrode Preparation:

TABLE 15. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper							13.0	0.0144
Nickel							12.0	0.0133
Cobalt							3.8	0.0042
Iron							3.6 (%)	39.8
Manganese							0.71 (%)	7.8
Chromium							58.0	0.0641
Vanadium							13.0	0.014
Titanium							160.0	0.1767
Scandium								
Calcium							2.5 (%)	27.6
Potassium							650.0	0.7179
Chlorine								
Sulphur							0.25(%)	2.76
Phosphorus							0.27(%)	2.98
Silicon							140.0	0.1546
Aluminum							0.72(%)	7.95
Magnesium							0.100(%)	1.10
Sodium							0.47 (%)	5.19
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron							17.0	0.0188
Beryllium							0.39	0.00043
Lithium							1.5	0.0017
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 15. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium							2.0	0.0022
Lanthanum							0.80	0.00088
Barium							19.0	0.021
Cesium							1.0	0.0011
Iodine							12.0	0.0133
Tellurium							0.66	0.00073
Antimony							9.8	0.011
Tin							3.3	0.0036
Indium							IS	
Cadmium							1.6	0.0018
Silver								
Palladium								
Rhodium								
Ruthenium								
Molybdenum							2.8	0.0031
Niobium							0.73	0.00081
Zirconium							3.9	0.0043
Yttrium							1.6	0.0018
Strontium							23.0	0.0254
Rubidium							5.5	0.0061
Bromine							24.0	0.0265
Selenium							<2.5	<0.0028
Arsenic							15.0	0.0166
Germanium							2.4	0.0027
Gallium							2.7	0.0030
Zinc							130.0	0.1436

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 15. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium							<0.81	<0.00089
Thorium							<3.3	<0.0036
Bismuth							0.73	0.00081
Lead							90.0	0.099
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten							4.5	0.0050
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium								
Neodymium							1.3	0.0014
Praseodymium							0.14	0.00015

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank)

TABLE 16. SSMS ANALYSIS SHEET, 1X

Contractor: Research Triangle Institute

Sample Site: U.S. Steel, Gary, IN Sample Acquisition Date: 6/26/78

Type of Source: Sinter Plant Windbox - before control device

Test Number: Sample ID Number: 1X

Sample Description: XAD-2, Resin (parr bombed) and XAD-2 Resin blank (parr bombed)

Responsible Analyst: GCA Date Analyzed:

Calculations and Report Reviewed By: Report Date:

Instrument: Resolution:

Internal Standard(s): Indium

Original Sample Volume or Mass: 130.33 grams at source

Dilution Factor: 25

Brief Description of Electrode Preparation:

1.00 grams XAD-2 resin parr bombed and taken up in 25 ml of solution; 4.0 ml of solution used in test. Same procedure used for sample and blank.

TABLE 16. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper		0.50	0.23	0.27			6.75	0.12
Nickel		0.32	0.81	NG			NG	NG
Cobalt		0.0023	0.0084	NG			NG	NG
Iron		3.5	4.5	NG			NG	NG
Manganese		0.086	0.11	NG			NG	NG
Chromium		0.24	0.72	NG			NG	NG
Vanadium		0.011	0.0077	0.003			0.075	0.0013
Titanium		0.18	0.067	0.11			2.75	0.048
Scandium								
Calcium		1.8	2.0	NG			NG	NG
Potassium		1.0	0.59	0.41			10.25	0.18
Chlorine								
Sulphur		18.0	8.2	9.8			245	4.32
Phosphorus		0.12	0.054	0.07			1.75	0.031
Silicon		3.9	2.6	1.3			32.5	0.57
Aluminum		8.6	3.1	5.5			137.	2.42
Magnesium		0.31	0.32	NG			NG	NG
Sodium		5.0	1.2	3.8			95	1.67
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron		0.24	0.22	0.02			0.5	0.009
Beryllium		< 0.0004	< 0.0003	< 0.0001			< 0.0025	< 0.00004
Lithium		0.010	0.006	0.004			0.1	0.0018
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 16. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/in^3 or $\mu g/L$
Cerium		<0.0072		<0.0072			< 0.18	< 0.0032
Lanthanum								
Barium		1.096	0.040	0.056			1.4	0.025
Cesium			0.012	NG				
Iodine								
Tellurium								
Antimony								
Tin		0.094	0.20	NG			NG	NG
Indium		IS	IS	IS			IS	IS
Cadmium								
Silver								
Palladium								
Rhodium								
Ruthenium								
Molybdenum			0.034	NG			NG	NG
Niobium			0.0017	NG			NG	NG
Zirconium								
Yttrium								
Strontium		0.039	0.019	0.020			0.5	0.0088
Rubidium		0.0072	0.034	NG			NG	NG
Bromine								
Selenium								
Arsenic		0.0093	0.0031	0.0062			0.155	0.0027
Germanium								
Gallium								
Zinc		0.13	0.12	0.01			0.25	0.0044

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 16. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth								
Lead			0.087				NG	NG
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten								
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium								
Neodymium								
Praseodymium								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($< 2\sigma$ blank)

TABLE 17. SSMS ANALYSIS SHEET, 1 IMP 1

Contractor: Research Triangle Institute

Sample Site: U.S. Steel, Gary, IN Sample Acquisition Date: 6/26/78

Type of Source: Sinter Plant Windbox - Before control device

Test Number: _____ Sample ID Number: 1 IMP 1

Sample Description: First Impinger and blank

Responsible Analyst: _____ Date Analyzed: _____

Calculations and Report Reviewed By: GCA Report Date: _____

Instrument: _____ Resolution: _____

Internal Standard(s): Indium

Original Sample Volume or Mass: 750 ml at source

Dilution Factor: None

Brief Description of Electrode Preparation: _____

20 ml of solution used in test.

TABLE 17. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper		13.0	0.0038	13.0			13.0	1.32
Nickel		0.11	0.011	0.10			0.10	0.010
Cobalt		0.0023		0.0023			0.0023	0.00023
Iron		0.65	0.35	0.30			0.30	0.030
Manganese		0.022	0.0087	0.013			0.013	0.0013
Chromium		0.050	0.0091	0.041			0.041	0.0042
Vanadium		0.0030		0.0030			0.0030	0.00030
Titanium		0.0008	0.010	NG			NG	NG
Scandium								
Calcium		0.17	0.29	NG			NG	NG
Potassium		0.14	0.072	0.007			0.07	0.0071
Chlorine								
Sulphur		100.0	0.83	99.2			99.2	10.1
Phosphorus		0.011	0.012	NG			NG	NG
Silicon		0.065	0.77	NG			NG	NG
Aluminum		0.11	0.11	0			0	0
Magnesium		0.041	0.043	NG			NG	NG
Sodium		0.25	0.97	NG			NG	NG
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron		0.0027	0.19	NG			NG	NG
Beryllium								
Lithium		< 0.0001	0.0002	NG			NG	NG
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 17. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/l$
Cerium		0.0008		0.0008			0.0008	0.00008
Lanthanum								
Barium		< 0.0028		< 0.0028			< 0.0028	< 0.00028
Cesium								
Iodine								
Tellurium								
Antimony								
Tin		0.092	0.100	NG			NG	NG
Indium		IS	IS	IS			IS	IS
Cadmium		0.0023		0.0023			0.0023	0.00023
Silver								
Palladium								
Rhodium								
Ruthenium								
Molybdenum		0.014		0.014			0.014	0.0014
Niobium								
Zirconium		0.0026		0.0026			0.0026	0.00026
Yttrium		0.0020		0.0020			0.0020	0.0002
Strontium		0.0014		0.0014			0.0014	0.00014
Rubidium								
Bromine								
Selenium		<0.0056		<0.0056			< 0.0056	<0.00057
Arsenic		0.0091		0.0091			0.0091	0.00092
Germanium								
Gallium								
Zinc		10.0	0.010	10.0			10.0	1.02

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 17. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth								
Lead		0.045		0.045			0.045	0.0046
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten								
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium								
Neodymium								
Praseodymium								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank)

TABLE 18. SSMS ANALYSIS SHEET, 1 Process Feed

Contractor Research Triangle Institute

Sample Site U.S. Steel, Gary, IN Sample Acquisition Date 6/26/78

Type of Source Sinter Plant - Raw Feed Material

Test Number _____ Sample ID Number _____

Sample Description Process - feed material

Responsible Analyst GCA Date Analyzed _____

Calculations and Report Reviewed By _____ Report Date _____

Instrument _____ Resolution _____

Internal Standard(s) Indium

Original Sample Volume or Mass 604.2 grams at source

Dilution Factor _____

Brief Description of Electrode Preparation _____

0.1015 gms used for test (Neat).

TABLE 18. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Copper							54.0	
Nickel							18.0	
Cobalt							3.9	
Iron							14.0 (%)	
Manganese							0.25 (%)	
Chromium							42.0	
Vanadium							37.0	
Titanium							150.0	
Scandium								
Calcium							4.1 (%)	
Potassium							330.0	
Chlorine								
Sulphur							0.36 (%)	
Phosphorus							590.0	
Silicon							1.4 (%)	
Aluminum							0.55 (%)	
Magnesium							1.3 (%)	
Sodium							400.0	
Fluorine								
Oxygen								
Nitrogen								
Carbon								
Boron							18.0	
Beryllium							0.80	
Lithium							3.1	
Hydrogen								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank).

TABLE 18. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Cerium							2.2	
Lanthanum								
Barium							21.0	
Cesium							0.28	
Iodine							< 1.1	
Tellurium								
Antimony							1.9	
Tin							1.8	
Indium							IS	
Cadmium								
Silver								
Palladium								
Rhodium								
Ruthenium								
Molybdenum							2.8	
Niobium							0.57	
Zirconium							4.1	
Yttrium							0.88	
Strontium							34.0	
Rubidium							1.4	
Bromine							< 4.6	
Selenium							< 0.46	
Arsenic							11.0	
Germanium							16.0	
Gallium							< 2.2	
Zinc							130.0	

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable ($<2\sigma$ blank).

TABLE 18. (cont'd)

Element	Line Used for Estimate	Uncorrected Sample Value	Blank Value	Corrected Sample Value	Sensitivity	High/Low Calibration Standards or Concentration Added	Assigned Concentration*	At Source Mass/Volume mg/m^3 or $\mu g/L$
Uranium								
Thorium								
Bismuth								
Lead							20.0	
Thallium								
Mercury								
Gold								
Platinum								
Iridium								
Osmium								
Rhenium								
Tungsten							< 1.7	
Tantalum								
Hafnium								
Lutecium								
Ytterbium								
Thulium								
Erbium								
Holmium								
Dysprosium								
Terbium								
Gadolinium								
Europium								
Samarium								
Neodymium								
Praseodymium								

*Results: PPM value (in original sample) or I - interference; NC - not computed; NG - sample value below blank; ND - not detectable (<2σ blank)

APPENDIX A

LEVEL 1 ORGANIC ANALYSES OF SAMPLE 1X, THE PROCESS FEED SAMPLE, AND INORGANIC ANALYSIS DATA

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TABLE A-1. LC ANALYSIS REPORT

Contractor: Research Triangle Institute

Sample Site: U.S. Steel, Gary, IN Sample Acquisition Date: June 26, 1978

Type of Source: Sinter Plant No. 3 Windbox before control device

Test Number: _____ Sample ID Number: 1X

Sample Description: XAD-2 and Module Rinse

Original Sample Volume or Mass: 130.33 gms Resin

Responsible Analyst: J. Cortese Date Analyzed: _____

Calculations and Report Reviewed By: Handy, Westbrook Report Date: _____

Column Flow Rate: _____ Column Temperature: _____

Observations: 2 mg GRAV and 0.0 mg TCO found in XAD-2 Blank

	TCO mg	GRAV mg	Total mg	Concentration[5] mg/M^3
Total Sample[1]	36.6	128	164.5	22.35
Taken for LC[2]	18.0	63.0	81.0	10.97
Recovered[3]	25.0	34.0	59	7.99

Fraction	TCO[4] in mg			GRAV[4] in mg			Total[4] mg	Concentration[5] mg/M^3
	Total	Blank	Corrected	Total	Blank	Corrected		
1	24.0	0.0	24.0	36.2	0.0	36.2	60.2	8.16
2	16.7	0.0	16.7	14.6	0.0	14.6	31.3	4.24
3	0.6	0.0	0.6	4.5	0.0	4.5	5.1	0.69
4	2.6	0.0	2.6	2.8	0.0	2.8	5.4	0.73
5	0.0	0.0	0.0	1.6	0.0	1.6	1.6	0.22
6	6.9	0.0	6.9	11.4	3.3	8.1	15.0	2.03
7	0.0	0.0	0.0	1.2	0.0	1.2	1.2	0.16
Sum	50.8	0.0	50.8	72.3	3.3	69	119.8	16.23

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Total mg divided by total volume

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TABLE A-2. IR REPORT--SAMPLE NO. 1X, CUT LC-1

XAD-2 Sample and Module Rinse

Total Sample GRAV = 36.2 mg

ν,cm^{-1}	I	Assignment	Possible Categories	I
2859-2959	S	CH, aliphatic	Aliphatics	100
1462	S	CH, aliphatic	Haloaliphatics	10
1380	S	CH, aliphatic		
722	M	CH, subst.		

TABLE A-3. IR REPORT--SAMPLE NO. 1X, CUT LC-2

XAD-2 Sample and Module Rinse

Total Sample GRAV = 14.6 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3030-3059	M	CH, aromatic	Haloaliphatics	10
2865-2959	S	CH, aliphatic	Subst. Benzenes	100
1603	M	C=C, aromatic	Halobenzenes	10
1456	S	CH, aliphatic	Fused aromatics	100
1380	M	CH, aliphatic		
1186, 1262	W	CH, aliphatic/ aromatic		
1034, 1092	M	CH, aromatic		
711-863	M	CH, multiplet		

TABLE A-4. IR REPORT--SAMPLE NO. 1X, CUT LC-3

XAD-2 Sample and Module Rinse

Total Sample GRAV = 4.5 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3059	M	CH, aromatic	Subst. Benzenes	100
2859-2959	S	CH, aliphatic	Halobenzenes	10
1603	W	C=C, aromatic	Fused aromatics	100
1456	M	CH, aliphatic		
1380	W	CH, aliphatic		
1263	W	CH, aliphatic/aromatic		
1092	M	CH, aromatic		
699-846	M	CH, multiplet		

TABLE A-5. IR REPORT--SAMPLE NO. 1X, CUT LC-4

XAD-2 Sample and Module Rinse

Total Sample GRAV = 2.8 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2862-2963	S	CH, aliphatic	Hetero N Compounds	100
1728	S	C=O, ketone	Hetero O Compounds	100
1603	W	C=C, aromatic	Hetero S Compounds	100
1466	S	CH, aliphatic	Nitriles	10
1383	M	CH, aliphatic	Ether, Epoxides	100
1276	S	COC, ether	Aldehydes, Ketones	100
1074-1122	M	CH, aromatic; COC, ether	Nitroaromatics	10
742	M	CH, subst.		

TABLE A-6. IR REPORT--SAMPLE NO. 1X, CUT LC-5

XAD-2 Sample and Module Rinse

Total Sample GRAV = 1.6 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2862-2961	S	CH, aliphatic	Hetero N Compounds	100
1726	S	C=O, ketone/ester	Hetero O Compounds	100
1603	W	C=C, aromatic	Hetero S Compounds	100
1380,1462	M	CH, aliphatic	Alkyl S Compounds	10
1287	S	COC, ester/ether	Nitriles	10
1070, 1123	M	CH, aromatic;		
		COC, ether/ester	Aldehydes, Ketones	100
742	M	CH, subst.	Nitroaromatics	10
			Ethers, Epoxides	100
			Alcohols	10
			Phenols	10
			Amines	10
			Amides	10
			Esters	100

TABLE A-7. IR REPORT--SAMPLE NO. 1X, CUT LC-6

XAD-2 Sample and Module Rinse

Total Sample GRAV = 8.1 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3358	M	NH or OH (broad)	Phenols	100
2859-2959	S	CH, aliphatic	Esters	100
1732	S	C=O, ester	Amines	100
1603	W	C=C, aromatic	Hetero N Compounds	100
1462	S	CH, aliphatic	Alkyl S Compounds	10
1380	M	CH, aliphatic	Sulfonic Acids, Sulfoxides	10
1274	S	COC, ester; CN, amine	Carboxylic Acids	10
1080-1180	M	OH, alcohol/phenol;	Alcohols	100
		CH, aromatic	Amides	10
717-834	W	CH, multiplet		

TABLE A-8. IR REPORT--SAMPLE NO. 1X, CUT LC-7

XAD-2 Sample and Module Rinse

Total Sample GRAV = 1.2

ν, cm^{-1}	I	Assignment	Possible Categories	I
2859-2959	S	CH, aliphatic	Phenols	10
1738	S	C=O, ester	Esters	100
1603	M	C=C, aromatic	Amines	10
1462,1380	M	CH, aliphatic	Hetero N Compounds	100
1263	S	COC, ester	Sulfonic Acids, Sulfoxides	10
1081-1180	W	COC, ester;		
		CH, aromatic	Alcohols	10
722-746	W	CH, subst.	Amides	10
			Carboxylic Acids	10

TABLE A-9. MASS SPECTROSCOPY REPORT--SAMPLE NO. 1X, CUT LC-1

XAD-2 Sample and Module Rinse

Categories	Relative Intensity
Aliphatics	100
Haloaliphatics	1

TABLE A-10. MASS SPECTROSCOPY REPORT--SAMPLE NO. 1X, CUT LC-2

XAD-2 Sample and Module Rinse

Categories		Relative Intensity
Haloaliphatics		1
Substituted Benzenes		10
Halobenzenes		1
Fused aromatics (MW < 216)		100
Fused aromatics (MW > 216)		100
Possible Identifications	**Mol. Wt.**	**Relative Intensity**
Phenanthracene, Anthracene	178	100
Fluoranthene, Pyrene	202	100
Benzanthracene, Chrysene	228	10
Benzofluoranthene, Benzopyrene	252	10
Dibenzanthracene	278	100

TABLE A-11. MASS SPECTROSCOPY REPORT--SAMPLE NO. 1X, CUT LC-3

XAD-2 Sample and Module Rinse

Categories		Relative Intensity
Substituted Benzenes		10
Halobenzenes		1
Fused Aromatics (MW < 216)		10
Fused Aromatics (MW > 216)		100
Possible Identifications	**Mol. Wt.**	**Relative Intensity**
Acenaphthylene	152	10
Phenanthracene, Anthracene	178	10
Fluoranthene, Pyrene	202	100
Benzanthracene, Chrysene	228	10
Benzofluoranthene, Benzopyrene	252	100
Indenopyrene, Benzoperylene	276	100
Dibenzanthracene	278	100
Dibenzopyrene	302	100

TABLE A-12. MASS SPECTROSCOPY REPORT--SAMPLE NO. 1X, CUTS LC 4-7

XAD-2 Sample and Module Rinse

Mass spectra for LC fractions 4-7 were too complex for unequivocal category identification. Assessment of LC fractions 4-7 should be based on LC/IR evaluation.

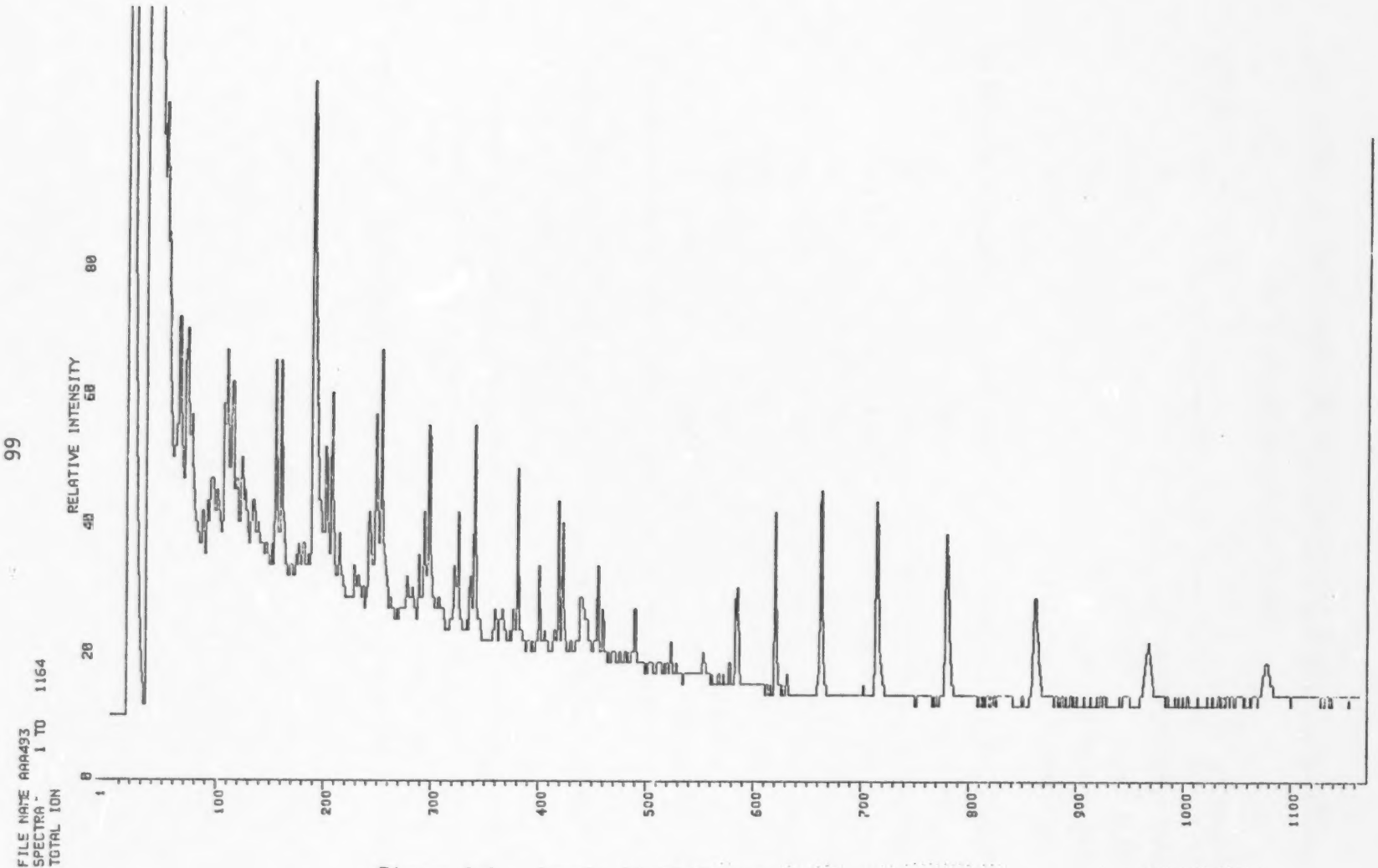

Figure A-1. Sample 1X GC-MS total ion current plot.

TABLE A-13. LC ANALYSIS REPORT

Contractor: Research Triangle Institute

Sample Site: U.S. Steel, Gary, IN Sample Acquisition Date: June 26, 1978

Type of Source: Sinter Plant No. 3, Feed Sample

Test Number: _____ Sample ID Number: 1 Process Feed

Sample Description: Process Feed Sample

Original Sample Volume or Mass: 604.2 grams (total extracted)

Responsible Analyst: J. Cortese Date Analyzed: _____

Calculations and Report Reviewed By: Handy, Westbrook Report Date: _____

Column Flow Rate: _____ Column Temperature: _____

Observations: _____

	TCO mg	GRAV mg	Total mg	Concentration[5] mg/Kg
Total Sample[1]	3.7	105.0	108.7	179.9
Taken for LC[2]	1.9	52.5	54.4	90.0
Recovered[3]	1:8	47.4	49.2	81.4

Fraction	TCO[4] in mg			GRAV[4] in mg			Total[4] mg	Concentration[5] mg/Kg
	Total	Blank	Corrected	Total	Blank	Corrected		
1	1.0	0.0	1.0	54.0	0.0	54.0	55.0	91.0
2	1.6	0.0	1.6	13.2	0.0	13.2	14.8	24.5
3	0.6	0.0	0.6	6.8	0.0	6.8	7.4	12.2
4	0.0	0.0	0.0	4.4	0.0	4.4	4.4	7.3
5	0.0	0.0	0.0	3.6	0.0	3.6	3.6	6.0
6	0.4	0.0	0.4	11.2	0.0	11.2	11.6	19.2
7	0.0	0.0	0.0	1.6	0.0	1.6	1.6	2.6
Sum	3.6	0.0	3.6	94.8	0.0	94.8	98.4	162.8

1. Quantity in entire sample, determined before LC
2. Portion of whole sample used for LC, actual mg
3. Quantity recovered from LC column, actual mg
4. Total mg computed back to total sample
5. Total mg divided by total volume

TABLE A-14. IR REPORT--PROCESS FEED SAMPLE, CUT LC-1

Total Sample GRAV = 54.0 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
2858-2959	S	CH, aliphatic	Aliphatics	100
1465	S	CH, aliphatic	Haloaliphatics	10
1380	S	CH, aliphatic		
723	M	CH, substituted		

TABLE A-15. IR REPORT--PROCESS FEED SAMPLE, CUT LC-2

Total Sample GRAV = 13.2 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3046	M	CH, aromatic	Haloaliphatics	10
2859-2955	S	CH, aliphatic	Substituted Benzenes	100
1602	W	C=C, aromatic	Halobenzenes	10
1457	M	CH, aliphatic	Fused aromatics	100
1377	M	CH, aliphatic		
1184	W	CH, aromatic/aliphatic		
778-949	M	CH, multiplet		

TABLE A-16. IR REPORT--PROCESS FEED SAMPLE, CUT LC-3

Total Sample GRAV = 6.8 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3048	W	CH, aromatic	Substituted Benzenes	100
2855-2954	S	CH, aliphatic	Halobenzenes	10
1703	W	C=O, ketone	Fused Aromatics	100
1604	W	C=C, aromatic		
1460	S	CH, aliphatic		
1378	W	CH, aliphatic		
1152	W	CH, aromatic, aliphatic		
815-882	W	CH, multiplet		
749	S	CH, substituted		

TABLE A-17. IR REPORT--PROCESS FEED SAMPLE, CUT LC-4

Total Sample GRAV = 4.4 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3396	W	NH or OH (broad)	Hetero N Compounds	100
3058	W	CH, aromatic	Hetero O Compounds	100
2856-2951	S	CH, aliphatic	Hetero S Compounds	100
1704	M	C=O, ketone	Nitriles	10
1609	M	C=C, aromatic	Ether, Epoxides	100
1460	S	CH, aliphatic	Aldehydes, Ketones	100
1377	W	CH, aliphatic	Nitroaromatics	10
1240, 1300	W	COC, ether; CH, aromatic/aliphatic		
878	W	CH, substituted		
753	M	CH, substituted		

TABLE A-18. IR REPORT--PROCESS FEED SAMPLE, CUT LC-5

Total Sample GRAV = 3.6 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3340	W	NH or OH (broad)	Hetero N Compounds	100
3053	W	CH, aromatic	Hetero O Compounds	100
2856-2953	S	CH, aliphatic	Hetero S Compounds	100
1714	S	C=O, ketone/ester	Alkyl S Compounds	10
1611	M	C=C, aromatic; NH, amine	Nitriles	10
1454	S	CH, aliphatic	Aldehydes, Ketones	100
1375	W	CH, aliphatic	Nitroaromatics	10
1303	W	COC, ester; CN, amine	Ethers, Epoxides	100
1152	W	COC, ester/ether; COH, alcohol/phenol	Alcohols	100
741-970	W	CH, multiplet	Amines	100
			Amides	10
			Esters	100

TABLE A-19. IR REPORT--PROCESS FEED SAMPLE, CUT LC-6

Total Sample GRAV = 11.2 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
3233	W	OH or NH (broad)	Phenols	100
3033-3058	W	CH, aromatic	Esters	10
2854-2951	S	CH, aliphatic	Amines	100
1661	S	C=O, amide	Hetero N Compounds	100
1611	M	C=C, aromatic; NH, amine, amide	Alkyl S Compounds	10
1461	S	CH, aliphatic	Sulfonic Acids, Sulfoxides	10
1379	M	CH, aliphatic	Carboxylic Acids	10
1003-1273	W	COH, alcohol/phenol	Alcohols	100
753-834	M	CH, substituted	Amides	100

TABLE A-20. IR REPORT--PROCESS FEED SAMPLE, CUT LC-7

Total Sample GRAV = 1.6 mg

ν, cm^{-1}	I	Assignment	Possible Categories	I
	QNS		Phenols	10
			Esters	10
			Amines	10
			Hetero N Compounds	10
			Sulfonic Acids	10
			Sulfoxides	10
			Alcohols	10
			Amides	10
			Carboxylic Acids	10

TABLE A-21. MASS SPECTROSCOPY REPORT--PROCESS FEED SAMPLE, CUT LC-1

Categories	Relative Intensity
Aliphatics	100
Haloaliphatics	1

TABLE A-22. MASS SPECTROSCOPY REPORT--PROCESS FEED SAMPLE, CUT LC-2

Categories		Relative Intensity
Haloaliphatics		1
Substituted Benzenes		10
Halobenzenes		1
Fused Aromatics (MW < 216)		10
Fused Aromatics (MW > 216)		100
Possible Identifications	**Mol. Wt.**	**Relative Intensity**
Naphthalene	128	10
Acenaphthylene	152	10
Phenanthracene, Anthracene	178	100
Fluoranthene, Pyrene	202	100
Benzanthracene, Chrysene	228	100
Benzofluoranthene, Benzopyrene	252	100
Indenopyrene, Benzoperylene	276	100

TABLE A-23. MASS SPECTROSCOPY REPORT--PROCESS FEED SAMPLE, CUT LC-3

Categories		Relative Intensity
Substituted Benzenes		10
Halobenzenes		1
Fused Aromatics (MW < 216)		10
Fused Aromatics (MW > 216)		100
Possible Identifications	**Mol. Wt.**	**Relative Intensity**
Phenanthracene, Anthracene	178	100
Fluoranthene, Pyrene	202	10
Benzanthracene, Chrysene	228	100
Benzofluoranthene, Benzopyrene	252	100
Indenopyrene, Benzoperylene	276	100
Dibenzopyrene	302	100

TABLE A-24. MASS SPECTROSCOPY REPORT--PROCESS FEED SAMPLE, CUTS LC 4-7

Sample weight of LC 7 was QNS for analysis. Mass spectra for LC fractions 4, 5, and 6 were too complex for unequivocal category identification. Assessment of LC fractions 4, 5, and 6 should be based on LC/IR evaluation.

TABLE A-25. INORGANIC ANALYSIS OF PROCESS FEED SAMPLE, NEAT

Element	Value (ppm)	Element	Value (ppm)
PB	20	ZN	130
W	< 1.7	CU	54
CE	2.2	NI	18
BA	21	CO	3.9
CS	0.28	FE	14 (%)
I	< 1.1	MN	0.25(%)
SB	1.9	CR	42
SN	1.8	V	37
IN	IS*	TI	150
MO	2.8	CA	4.1 (%)
NB	0.57	K	330
ZR	4.1	S	0.36 (%)
Y	0.88	P	590
SR	34	SI	1.4 (%)
RB	1.4	AL	0.55 (%)
BR	< 4.6	MG	1.3 (%)
SE	< 0.46	NA	400
AS	11	B	18
GE	16	BE	0.80
GA	< 2.2	LI	3.1

*IS - indicates the element is an internal standard

TABLE A-26. INORGANIC ANALYSIS OF SAMPLE NO. 1C 310

3 μ + 10 μ Cyclone Catches

Element	Value (ppm)	Element	Value (ppm)
U	< 0.81	SE	< 2.5
TH	< 3.3	AS	15
BI	0.73	GE	2.4
PB	90	GA	2.7
W	4.5	ZN	130
ND	1.3	CU	13
PR	0.14	NI	12
CE	2.0	CO	3.8
LA	0.80	FE	3.6 (%)
BA	19	MN	0.71 (%)
CS	1.0	CR	58
I	12	V	13
TE	0.66	TI	160
SB	9.8	CA	2.5 (%)
SN	3.3	K	650
IN	IS*	S	0.25 (%)
CD	1.6	P	0.27 (%)
MO	2.8	SI	140
NB	0.73	AL	0.72 (%)
ZR	3.9	MG	0.100 (%)
Y	1.6	NA	0.47 (%)
SR	23	B	17
RB	5.5	BE	0.39
BR	24	LI	1.5

*IS - indicates the element is an internal standard

TABLE A-27. INORGANIC ANALYSIS OF SAMPLE NO. 1C1F

Aqua Regia Digest of filter and 1 μ cyclone

Element	Value (ppm)	Element	Value (ppm)
BI	0.040	GA	0.0074
PB	25	ZN	1.6
TL	0.28	CU	1.1
CE	0.021	NI	0.68
LA	0.0044	CO	0.010
BA	0.13	FE	250
CS	0.0007	MN	5.9
TE	0.068	CR	0.30
SB	0.050	V	0.067
SN	0.041	TI	0.39
IN	IS*	CA	210
CD	0.100	K	220
MO	0.058	S	73
NB	0.0015	P	3.0
ZR	0.015	SI	3.0
Y	0.0046	AL	20
SR	0.12	MG	65
RB	2.6	NA	MC**
BR	0.35	B	4.4
SE	< 0.100	BE	0.0087
AS	0.11	LI	0.18
GE	0.0093		

*IS - indicates the element is an internal standard

**MC - indicates the element is a major component

TABLE A-28. INORGANIC ANALYSIS OF SAMPLE NO. 1X

XAD-2 Resin (Parr Bombed)

Element	Value (ppm)	Element	Value (ppm)
CE	< 0.0072	V	0.011
BA	0.096	TI	0.18
SN	0.094	CA	1.8
IN	IS*	K	1.0
SR	0.039	S	18
RB	0.0072	P	0.12
AS	0.0093	SI	3.9
ZN	0.13	AL	8.6
CU	0.50	MG	0.31
NI	0.32	NA	5.0
CO	0.0023	B	0.24
FE	3.5	BE	< 0.0004
MN	0.086	LI	0.010
CR	0.24		

*IS - indicates the element is an internal standard

TABLE A-29. INORGANIC ANALYSIS OF SAMPLE NO. 1X-BLANK

XAD-2 Resin Blank (Parr Bombed)

Element	Value (ppm)	Element	Value (ppm)
PB	0.087	MN	0.11
BA	0.040	CR	0.72
CS	0.012	V	0.0077
SN	0.20	TI	0.067
IN	IS*	CA	2.0
MO	0.034	K	0.59
NB	< 0.0017	S	8.2
SR	0.019	P	0.054
RB	0.034	SI	2.6
AS	0.0031	AL	3.1
ZN	0.12	MG	0.32
CU	0.23	NA	1.2
NI	0.81	B	0.22
CO	0.0084	BE	< 0.0003
FE	4.5	LI	0.006

*IS - indicates the element is an internal standard

TABLE A-30. INORGANIC ANALYSIS OF SAMPLE NO. 1 IMP 1

First Impinger Solution

Element	Value (ppm)	Element	Value (ppm)
PB	0.045	FE	0.65
CE	0.0008	MN	0.022
BA	< 0.0028	CR	0.050
SN	0.092	V	0.0030
IN	IS*	TI	0.0008
CD	0.0023	CA	0.17
MO	0.014	K	0.14
ZR	0.0026	S	100
Y	0.0020	P	0.011
SR	0.0014	SI	0.065
SE	< 0.0056	AL	0.11
AS	0.0091	MG	0.041
ZN	10	NA	0.25
CU	13	B	0.0027
NI	0.11	LI	< 0.0001
CO	0.0023		

*IS - indicates the element is an internal standard

TABLE A-31. INORGANIC ANALYSIS OF SAMPLE NO. 1 IMP 1-BLANK

First Impinger Solution Blank (30% Peroxide)

Element	Value (ppm)	Element	Value (ppm)
SN	0.100	K	0.072
IN	IS*	S	0.83
ZN	0.010	P	0.012
CU	0.0038	SI	0.77
NI	0.011	AL	0.11
FE	0.35	MG	0.043
MN	0.0087	NA	0.97
CR	0.0091	B	0.19
TI	0.010	LI	0.0002
CA	0.29		

*IS - indicates the element is an internal standard

APPENDIX B

DATA OBTAINED AND OBSERVATIONS MADE AT SINTER PLANTS NOS. 2 AND 3

SINTER PLANT NO. 2

Sinter Plant Operation

The No. 2 sinter plant has two identical strands with a rated capacity of 2900 tons/day. Table B-1 lists the strand design data. The feed material for this plant contains no revert materials (cinder, slag, blast furnace flue dust, sludge, boring, turnings, or mill scale). Feed materials used during this test were: OL13F ore, QCM fines, dolomite, limestone, coke, and cold and hot return fines from the sinter breaker. Cyclone and ESP fines are also returned to the conveyor belt via table feeders. There is no device to weight the amount of each material added to the belt. Ratios of materials added are determined by catching material from the table feeder in a pan placed on the belt. These catches are reported to the strand operator as pounds caught per pass. The operator makes changes in these feed rates based on the windbox temperatures and sinter quality being produced.

SASS Tests - 6/22/78

The SASS system was scrubbed with soap, rinsed with water, passivated with 15 percent nitric acid, and rinsed in succession with dionized water, isopropyl alcohol, and methylene chloride. XAD-2 resin was added to the canister, then the system was assembled and leak checked. After leak checking and replacement of a cooling water pump, the impinger solutions were added. The first sampling run began at about 4:40 pm (6/22/78) from the windbox gas main just before the cyclones. The filter (< 1 micron dust) blinded in about 10 minutes, requiring shut down and filter replacement. This experience was typical of the sampling effort. Five filters were used in collecting about 250 cubic feet of gas (sampling was stopped about 8:15 pm). The system was disassembled and samples recovered strictly according to Level 1 procedures. Concern for maintenance of sample integrity was high among the Acurex team.

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TABLE B-1. NO. 2 SINTER PLANT DESIGN DATA

Depth of bed on strand	11.5"
Width of bed	6'
Length of strand	118'
Number of windboxes	16
Number of pallets	129
Size of pallets	6' x 2'
Size of pallet bars	3/4"
Pallet bar spacing	3/32"
Seal between grate and windboxes	Mechanical
Ignition hood length	6'
Ignition hood type	Radiant
Ignition hood fuel	Natural gas
Air pollution control device on discharge	No
Sinter breaker	Yes
Hot screens for sinter	No
Sinter cooler type	Thermal updraft
Air pollution control device on cooler	No
Air pollution control on windbox	Cyclones, ESP

4:00 pm FEED RATES (PAN WEIGHTS)

OL13F ore	QCM Fines	Cold Fines	Coke	Dolomite	Lime	Total Fresh Feed
41b 8 oz.	81b 8 oz.	21b 4 oz.	1 1b 8 oz.	21b 6 oz.	31b 9 oz.	241b 3 oz.

WINDBOX TEMPERATURES, °F

Time	#8	#13	#14	#15	#16	Fan
2:10	--	625	480	425	275	285
4:00	310	650	600	500	350	290
6:30	280	620	510	435	275	295
7:28	250	550	500	460	310	285

WINDBOX VACUUM IN W. C.

Time	#2	#4	#6	#8	#10	#12	#14	#16	Fan
2:10						19	20	17	31
4:00						18	20	16	30
6:30	19	19	15	17	16	18	20	15	30
7:28	19	15	16	18	17	19	19	15	30

SAMPLES TAKEN, TIME

Feed to Sinter Machine	Individual Feed Samples
5:55 pm	6:05 pm
6:30	6:35
7:28	7:24
8:03	8:10

SINTER PLANT NO. 3

Sinter Plant Operation

This system is of more sophisticated design than the No. 2 sinter plant. All feed materials enter via weigh belt feeders and the weights are displayed in the control room. The strand is 8 ft wide (1293 ft^2). Design production rate is 5000 tons/day. The plant does not use a hearth layer. The first 50-70 percent of the strand is covered with a hood through which recycled air from the sinter cooler is returned (as a heat conservation measure). The sinter breaker is hooded and fugitive emissions are captured by an induced draft fan. This system worked quite well except for a short period when water flow to the sinter mix was lost. This strand uses scrap materials and sludges in addition to ore fines, coke, limestone, and dolomite. Normally these materials are fed from separate table feeders, however, during this test a blend was made prior to entering the sinter plant. Because of the design of the sinter feeder (sinter distributed by drum roller), a sample of the composite actually being fed to the machine could not be obtained. A sample containing all components except hot return fines was obtained.

Sampling was started at 1:15 pm in the windbox gas main before the cyclones and ESP. The filter (< 1 micron) plugged in about 9 minutes. This experience was typical of the sampling effort. Eight filters were used to collect about 250 cubic feet of gas. After the third sampling period, the filter holder was damaged (stainless steel screw fitting froze). The only replacement available had a teflon lining on the back side of the holder. This was used for the remaining five sampling periods. In addition to this problem, the sinter machine was stopped twice for periods of 10 and 30 minutes. In both cases, the machine was allowed to stabilize for a period equaling its downtime before sampling proceeded. The last run terminated at 8:30 pm. Sample recovery was strictly according to Level 1 procedures. The Acurex team exercised care in maintaining sample integrity.

WINDBOX TEMPERATURES, °F

Time	7	12	16	17	18	19	20	21	22	23	24	Fan
1:20	350	500	--	630	570	--	420	350	650	200	220	330
1:50	350	480	--	580	580	--	420	370	670	220	220	330
2:20	350	320	--	480	500	--	350	550	570	520	530	320
5:12	345	470	--	495	500	--	300	300	500	300	300	300
5:50	340	330	--	440	445	--	310	320	400	310	310	300
6:30	320	140	--	360	320	--	350	200	270	190	210	270
7:57	330	280	--	370	340	--	300	200	380	200	200	335
8:20	290	310	--	410	460	--	220	340	400	450	330	250

WINDBOX VACUUM, IN. W.C.

Time	1	2	7	12	16	17	18	19	20	21	22	23	24	Fan
1:20	15	24	5	25	22	--	14	17	17	17	10	17	12	35
1:50	13	21	5	23	23	--	15	18	17	17	12	20	12	35
2:20	12	23	5	25	25	--	12	20	20	19	15	22	12	35
5:12	15	24	6	24	25	--	18	18	19	18	15	22	12	34
5:50	17	25	7	27	27	--	18	23	22	20	17	21	17	34
6:30	17	25	7	27	27	--	21	24	23	22	--	27	17	37
7:57	15	27	7	24	27	--	20	24	24	23	17	25	17	38
8:30	16	27	7	28	28	--	21	24	23	23	17	24	15	38

TABLE B-2. FEED COMPONENTS RATES, CONTROL HOUSE CHARTS (TON/HR)

Component	TIME 1:25	2:20	5:12	5:50	6:30	7:57	8:30
1. Blend & QCM	150	150	157	150	130	135	140
2. Dolomite	10	10	10.5	10.5	10	9	9.5
3. Limestone	20	20	19.5	23	18	18	19.5
4. Coke	4	4.2	7.6	8.3	8	5.9	6.4
5. Cold Fines	50	60	58	58	80	75	60
6. Hot Fines	0-40	42	82	60	200	180	>200
7. Total Mix	300	325	365	350	450	360	330
8. Total Mix - Hot Fines	300	305	295	310	350	260	270
9. Water		18 gpm	10 gpm	14 gpm	48	48	17

Component	INTEGRATOR READING 1:20	7:50	Avg. ton/hr
1	791635	792429	122
2	371083	371622	8.3
3	124680	125576	13.8
4	911066	911374	4.7
5	918955	921800	44
6	189349	190113	118
7	827984	829990	309
8	---	No Integrator	---
9	743550	743550	---

Sinter bed temperature just after ignition hood 1650°F at 1:49, 1725°F at 2:20, less than 1200°F at 5:12 until test end.

Sinter strand speed 12 ft/min all day (except outages).